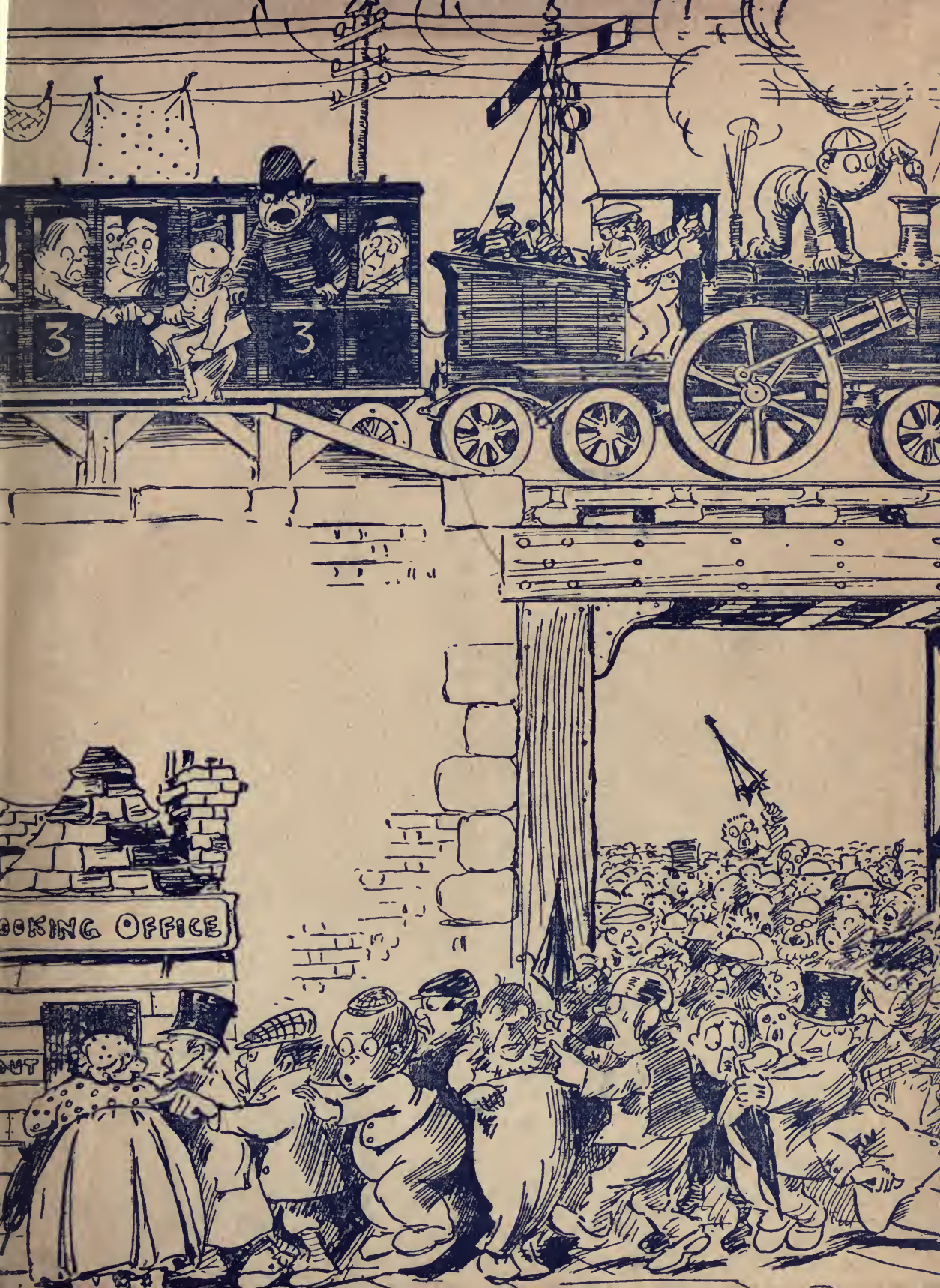
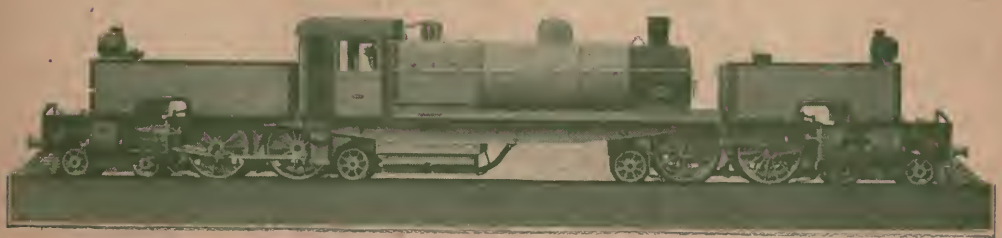
THE WONDER BOOK OF RAILWAYS

UNIVERSITY OF TORONTO
3 1761 01288705 5

1
RAILWAY TIME


3
3
BOOKING OFFICE

THE WONDER BOOK OF RAILWAYS



[E. N. A.

THE BARMEN-ELBERFELD SUSPENSION RAILWAY.

Digitized by the Internet Archive
in 2007 with funding from
Microsoft Corporation

http://www.archive.org/details/wonderbookofrail00golduoft

Gold

THE WONDER Book of Railways FOR BOYS AND GIRLS

174707.
20.10.22

WITH
TWELVE COLOUR PLATES AND NEARLY 300 ILLUSTRATIONS

NINTH EDITION—ALMOST ENTIRELY NEW

EDITED BY HARRY GOLDING

WARD, LOCK & CO. LTD.
LONDON AND MELBOURNE

WONDER BOOKS

UNIFORM WITH THIS VOLUME

Each with from Twelve to Sixteen Colour Plates

THE : : WONDER Book of Aircraft

An almost entirely new issue of this popular volume, describing and illustrating all types of aeroplanes, airships, flying-boats, etc.

THE : : WONDER Book of the Navy.

Tells how the Navy proved again a "sure shield" in the years of the Empire's trial. The articles are all by leading naval experts, and the pictures represent every phase of life afloat and ashore, in War and in Peace

THE : : WONDER Book of Ships.

Describes in simple language the great liners and other vessels of the Mercantile Marine, and is crowded with pictures that make an instant appeal to all who love the sea.

THE : : WONDER Book of Soldiers.

A mine of information on Army life and military matters generally. No more welcome present could be given to the youngster whose father or uncle has been, or is, a soldier.

THE : : WONDER Book of Empire.

Tells all about the lands under the Union Jack, and the people who live in them, including the former German Colonies. Crowded with pictures and interesting facts and stories.

THE : WONDER Book of Children.

This handsome volume, with its crowd of colour plates and interesting photographs, and its bright, chatty articles, gives glimpses of children in all parts of the world and of the people with whom they dwell.

THE : : WONDER Book of Animals.

This well-known volume is not merely a picture book, or a story book, or a natural history book, but a blend of all three, with many entertaining and instructive features.

THE WONDER BOOK.

All young people agree that there is no present for Christmas or the Birthday to equal *the* Wonder Book, of which an entirely new volume is published every autumn.

The LITTLE WONDER BOOKS are for Little People. Even tiny toddlers who cannot read laugh at the funny pictures (all in colour) and learn the stories by heart. There are nearly twenty volumes to choose from.

4–6–2 EXPRESS LOCOMOTIVE, CANADIAN PACIFIC RAILWAY.
A locomotive of this type drew the Prince of Wales's train during his tour through Canada in 1919.

COLOUR PLATES

The Tunnel Ahead. From the footplate of a Great Northern Express.
Drawing by René Bull . . . . . *Front Cover*

Interior of a Great Western 4–6–0 Locomotive . . *Double-page Frontispiece*

Scotch Express (London & North-Western Railway) . . . *Faces p.* 16

The "Cornish Riviera" Express (Great Western Railway) . . „ 32

Leeds and Bradford Luncheon Car Express (Great Northern Railway) . „ 48

New York-Chicago Express (Pennsylvania Railway) . . . „ 64

West to East Coast Express (Lancashire & Yorkshire Railway) . „ 96

Driver and Fireman at Work on an Express Locomotive . . „ 112

Rotary Snow-Plough (Southern Pacific Railway) . . . . , 128

The Southern Belle (London, Brighton & South Coast Railway) . „ 160

Canadian Pacific Transcontinental Express . . . . . „ 192

Pilatus Rack Railway, Switzerland . . . . . „ 224

A PACIFIC TYPE EXPRESS LOCOMOTIVE ON THE ESKDALE LIGHT RAILWAY (15-INCH GAUGE).

CONTENTS

	PAGE
What Makes the Engine Go ?	9
The Porter's Bank Holiday (*a Recitation*)	20
Express Passenger Engines	23
Famous Expresses of all Countries	33
The Concert Party (*story*)	43
Twice Round the Clock	47
The Lost Lunch (*verses*)	53
The First Locomotives	55
The First Railways	62
Signals and Signalling—I	68
Signals and Signalling—II	76
Signals for Signalmen	85
Monsters of the Rail	87
Early Days	91
The Christmas Porter (*verses*)	96
Railway Carriages, Old and New	97
Railway Head Codes	109
Plucky Little Arlington (*story*)	113
Locomotives of the Empire	119
Train Ferries	127
The Tale of a Letter	129
Goods and Mineral Locomotives	133
"Tickets, Please!"	139

CONTENTS

	PAGE
Some Wonderful Railway Bridges	143
Locomotives of all Countries	149
Railways in Time of War	157
The Tube Railways of London	161
Passenger Tank Engines	169
Staff Signals	174
The 19.15 Express	176
The World's Longest Electrified Railway	177
Drudges of the Line	183
Royal Trains	187
The Red Flag Man (*story*)	193
Engine Building and Repairing	199
Railways Queer and Quaint	205
The Cape to Cairo Railway	211
Railway Uniforms	219
How Many Miles an Hour?	224
Mountain Railways	225
The Largest Railway Stations in the World	231
The Break-down Train	237
The Handymen of the Line	241
The Canadian Pacific Railway	244
Electric Railways	249

A GOOD HAUL.

[E. N. A.

A CONTRACTOR'S ENGINE BEING SWUNG ACROSS A CANYON, RIO GRANDE RIVER, NEW MEXICO.

The engine, weighing 20 tons, was run across on two cableways extended between supporting towers 1,450 feet apart. The actual span of the river bed is 280 feet.

[*F. E. Mackay.*

THE GREAT WESTERN BIRMINGHAM EXPRESS PICKING UP WATER AT RUISLIP.

What Makes the Engine Go?

THERE are several kinds of locomotive engines, for the word "locomotive" means only that the engine is able to move from place to place by its own power. We have electric, compressed air, petrol, and other locomotives, besides those using steam; but unless we are told that one of these is meant it is generally the steam railway locomotive engine that is referred to, and that is the only kind with which we are here concerned.

The steam locomotive works on the same principle as any other steam engine. There must be the boiler in which to make steam, the engine in which the steam does its work, and supplies of coal and water. But to enable the locomotive to travel on rails and to pull passenger carriages or goods wagons, it is necessary to fit these and other parts together in small space, and to arrange them so that the steam can be applied in the best way to cause the machine to travel fast or slow, to start or stop, to go backwards or forwards, and to pull trains as required.

This is not so easy as may appear, and some of the old locomotives

were very queer-looking machines. But seventy or eighty years ago engines had taken the form still seen on every railway, although they have grown bigger and bigger, and now do work that the early makers never dreamt of expecting from them.

First, then, there is a strong frame of thick steel plates to carry the boiler and the mechanism. This frame is fitted with boxes to receive the axles of the wheels. Generally, some of these wheels are for carrying purposes only. That is, they take no part in causing the locomotive to travel, and merely carry some of the weight and help to make the engine move smoothly and safely. The important wheels are those which are caused to revolve by the steam working in the engine proper.

In early locomotives for express trains there was only one pair of *driving* wheels, and these were generally of large size. For the much heavier goods train at least two pairs of wheels were connected by rods, so that while one pair was actually worked by the steam, other wheels attached to them were forced to turn at the same speed. By this means, instead of one pair of wheels, with their small grip on the rails, having to do all the work, there were four or six wheels

[*F. E. Mackay.*

SCOTCH EXPRESS, LONDON & NORTH WESTERN RAILWAY.

[*F. E. Mackay.*

SCOTCH EXPRESS LEAVING KING'S CROSS, GREAT NORTHERN RAILWAY.

gripping the rails at the same time. Therefore, even in early days, goods engines had four or six wheels (two or three on each side) connected by *coupling* or *side* rods; and as passenger and express trains have become heavier it is now the custom to build their engines, too, with four or six fairly large wheels coupled together. All goods engines now have at least six smaller wheels coupled together, and many have four or even more on each side.

In most engines only one pair of wheels is actually worked by the steam, the coupling rods merely transferring some of the power to other wheels by forcing them to revolve with them. The grip on the rails thus obtained is termed *adhesion*, and depends upon the weight which rests on each wheel. The rails are of smooth steel and the wheel tyres are smooth; yet "grip," or "adhesion," sufficient to pull hundreds of tons is obtained. This is due entirely to the weight on the wheels; otherwise they would only slip on the rails instead of moving along. Each wheel has at least seven or eight tons weight resting upon it, sometimes ten or more tons, so that a six-coupled engine has nearly sixty tons to give it adhesion, while a "single-driver," with only one

Photo by] [*F. J. Mortimer, F.R.P.S.*

THE GATE OF GOOD BYE.

A daily scene at Victoria Station during the War.

pair of wheels to do all the work, has only nineteen or twenty tons at most.

All wheels are a little larger on one side, and it is these "flanges," as they are called, which keep the engine on the rails. But without weight the wheels would lift so that the flanges could rise and slip over the rails. Therefore the weight of the whole engine, on carrying as well as on coupled wheels, is important in causing it to keep on the rails and to travel safely on curves and at high speed, while the weight on the coupled wheels is necessary in order that the required "grip" on the rails can be obtained.

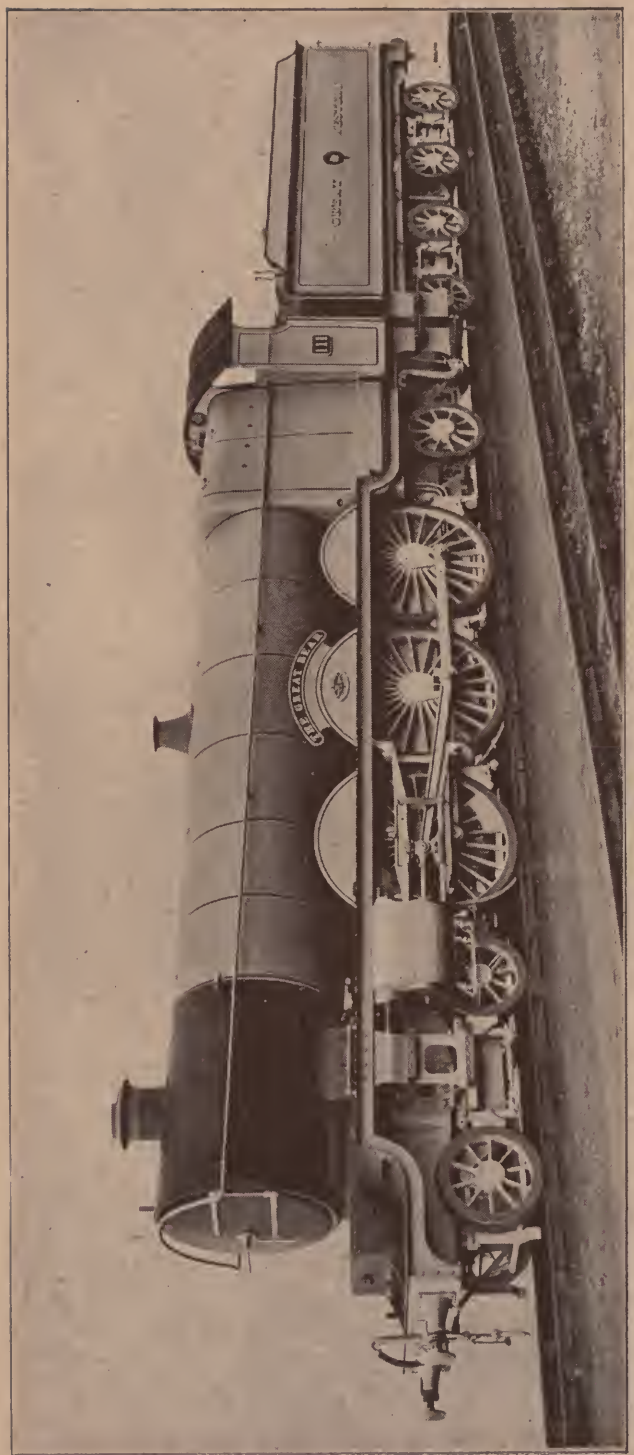
Most express engines have four carrying-wheels in front, fitted in a frame which is pivoted on to the main frame in such a way that it can swivel a little. This pivoted frame is called a *bogie*, and by its movement helps to guide the rest of the engine round curves and over points from one line to another. Some engines have a kind of two-wheeled bogie instead, called a *pony-truck*. For certain classes of engines bogies or pony-trucks are provided *behind* the coupled wheels as well as, or instead of, in front.

It is now necessary to consider the steam, or working, part of the engine. The largest and most noticeable feature is, of course, the *boiler*. Here there is a furnace, the heat of which turns the water into steam; but we must first of all understand what is meant by *pressure*.

If we boil water in an open saucepan it is converted into steam, but as the steam can get away it has no pressure and is of little, if any, use. But in a saucepan with a tight lid the steam cannot escape, though more of it is being made all the time, so that it gradually gets force, or pressure, until it is strong enough to lift the lid.

For a locomotive engine the steam must have considerable pressure, and the boiler needs to be very strong to withstand the enormous power of the steam within. How great this strain is, can be realized if you like to work out how many tons of pressure, at the rate of 200 pounds on every square inch, a boiler with a plate surface of about 30,000 square inches has to stand.

The boiler is in the form of a cylinder of steel plates riveted together, with a diameter of about 5 feet, and a length of 12 feet or so. At the front it is closed in by a steel plate called the *front tube plate*, and at the back end it is joined to the *outer firebox*. This outer firebox is only a casing, but inside it is a box of copper plates in which is



THE GREAT BEAR, GREAT WESTERN RAILWAY.

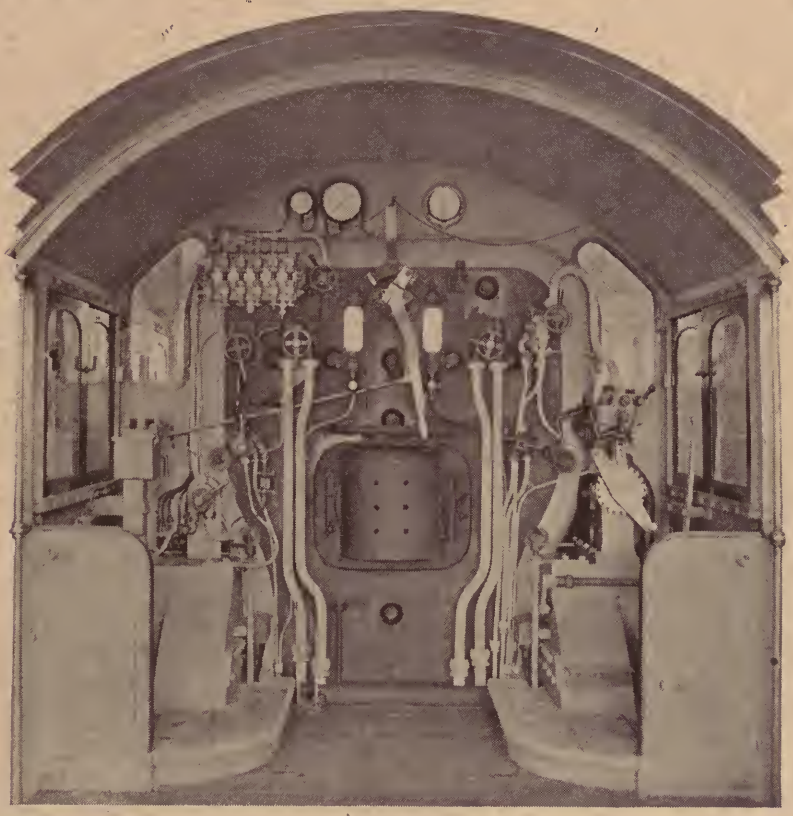
The largest passenger engine in Great Britain. Some notes on this mammoth locomotive will be found on p. 30.

the furnace, and this is the *inner firebox*, or firebox proper.

The inner firebox is connected with the outer firebox only at the bottom directly, but it is also attached by some hundreds of copper stay bolts all round the back and sides. The front plate is pierced with two or three hundred holes, and in these the ends of long tubes, about 2 inches in diameter, are fitted. These tubes extend right through the barrel to the plate which closes the front end of the boiler barrel, and which receives their other ends. This plate is therefore called the *front tube plate*, while the tube plate of the inner firebox is called the *back tube plate*.

In the fire-

box is the grate for the fire, and an opening at the back is the *fire-hole*, closed by a *fire-door*. Here the fireman supplies coal to keep the fire going, usually at such a rate that on a journey of a hundred miles he will have to fire about two tons of coal, if not more, so that he does not have an easy time. The grate itself may be 8 feet long and 4 feet wide, so that he has hard work to throw the coal to the more distant parts of the fire.

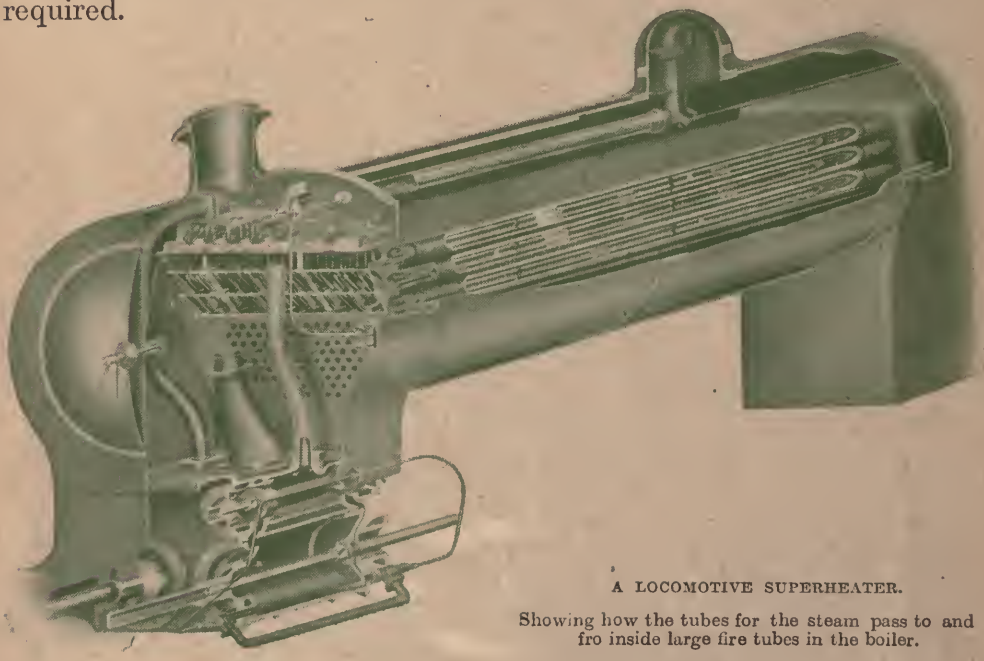


FOOTPLATE AND CAB OF A 4–4–0 EXPRESS LOCOMOTIVE, GREAT CENTRAL RAILWAY.

From the grate the flames and smoke pass through the tubes, so that the water in the boiler is heated not only from the inner firebox itself, which has water all round it and on top, but also by the tubes as these pass through the water. In front of the barrel is the *smokebox*, on which is the chimney, and here the smoke from the fire escapes after it has done its work in the boiler.

The top part of the boiler barrel is empty, though the water has to be high enough to cover all the tubes and the top of the inner fire-

box by six or seven inches at least, and in this space the steam collects. But as the water is boiling furiously, and there is a lot of splashing, in most engines a *steam dome* is fitted on top of the barrel so that the steam can rise further from the water. Inside the dome is a pipe carried up nearly to the top, and this pipe collects steam as dry as possible and then passes through the barrel into the smokebox, where it divides to lead steam away to the cylinders where the actual work is done. A valve in the steam dome is worked by the driver's *regulator* handle, and allows steam to be turned on or shut off as required.



A LOCOMOTIVE SUPERHEATER.

Showing how the tubes for the steam pass to and fro inside large fire tubes in the boiler.

In most engines nowadays steam is superheated before it is used. That is, it is heated again after it has left the boiler, so that particles of water in it are turned into steam, and the steam is made hotter than it otherwise would be. This process of "superheating," or "overheating," is of great value, but need not be gone into now. We must, however, consider how the superheating is effected. The top three rows of tubes in the boiler are made of larger size than the others, about $5\frac{1}{2}$ inches in diameter, and in these some small steam tubes are fitted so that the steam inside these smaller tubes can pass to and fro several times. Smoke and flame from the firebox are, of course, passing through the large tubes, to heat the water outside them, but

SCOTCH EXPRESS (London and North-Western Railway).

The locomotive is the "Lord Rathmore," one of the "Sir Gilbert Claughton" class, 4-6-0.

[*F. E. Mackay.*

NORFOLK COAST EXPRESS, GREAT EASTERN RAILWAY.

they at the same time heat the steam in the small inner tubes and so cause the steam to be superheated.

In the smokebox is a *header*, a steel box divided into two sections. Steam from the steam dome enters one section, goes thence through the small tubes referred to, and comes back to the other section of the header. From this it passes to the *cylinders*.

Most engines have two cylinders ; some have three or four. These cylinders may be described as closed boxes, and in each there is a sliding block, or *piston*. Steam is admitted at one end of the cylinder, and by its pressure forces the piston to the other end. This steam is then allowed to escape, while a fresh lot is admitted at the other end of the cylinder to force the piston back again. This goes on in each cylinder all the time, so that the piston is moving to and fro, and this causes a *piston rod* connected with it and passing through one end of the cylinder to move in the same way. Jointed to the other end of the piston rod is a *connecting rod*, and this is pivoted either to the outside of a driving-wheel—if the cylinders are outside the frames, as in many engines—or is connected with a *crank* formed in the axle of the driving-wheels. The action is, in fact, somewhat similar to that

of a cyclist's feet acting upon the pedals of his machine; and so the to-and-fro movements of the piston cause the wheels to rotate.

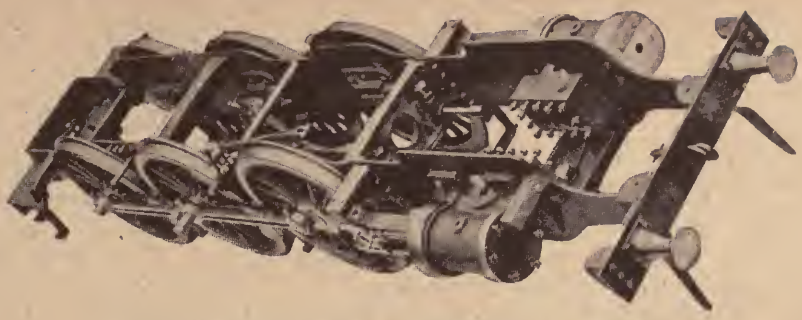
In an engine with two cylinders these are arranged so that when one piston is at one end or the other of its movement, or *stroke*, the other piston is half-way along and therefore exerting its greatest power.

For admitting steam to the cylinders and cutting it off and allowing used steam to escape, a *slide valve*, or *piston valve*, working in a *steam chest* alongside the cylinder is used. Steam from the boiler or from the superheater header enters the steam chest, from which openings lead to the ends of the cylinder, and also through a passage away to the smokebox for escape by the chimney, and the slide or piston valve is so moved to and fro that it opens or closes these openings or passages to admit steam to one end or the other of the cylinder or to allow used steam to get away.

A GREAT NORTHERN SUPERHEATED "ATLANTIC."

For working these valves a *valve gear* is employed. In some engines this is inside the frames, but in most big modern locomotives it is fitted outside the wheels. This valve gear has to provide for causing the engine to work either forward or backward, and is therefore governed by a *reversing gear* worked by a *reversing lever*, or by a *reversing wheel* in the driver's cab. Sometimes this lever or wheel is worked by a small steam engine of its own, for the parts to be moved on a big engine are heavy, and place a great strain on the driver.

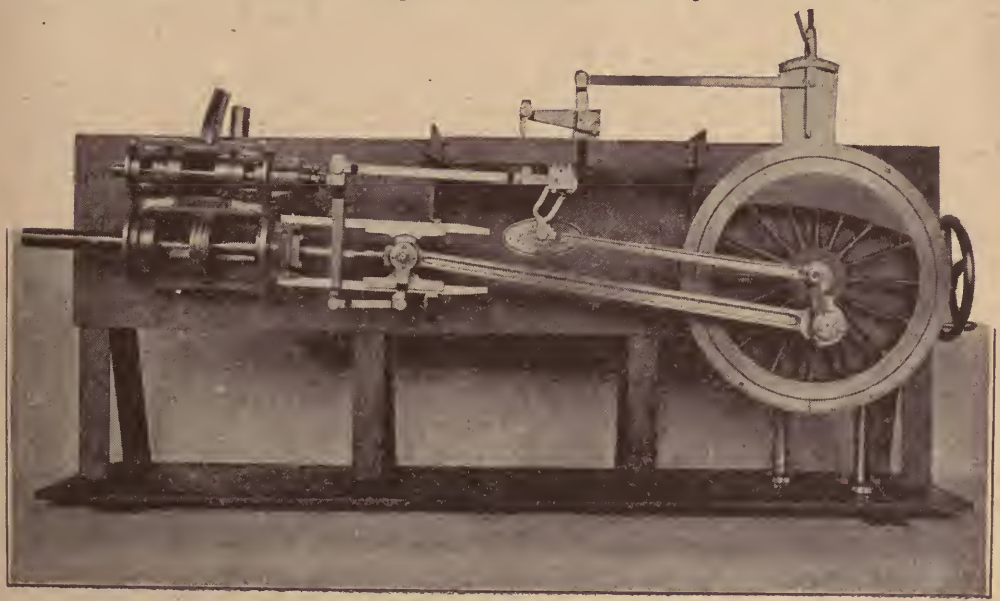
Steam which has done its work in the cylinders passes into the *blast pipe* in the smokebox directly under the chimney. It still has considerable force left in it, and this is very important, as the steam is passed into the chimney with a strong blast and so provides a *draught* upon the fire. This draught is, in fact, strong enough to draw lumps of burning coal from the fire right through the long tubes and even



CHASSIS OF A MODEL GREAT CENTRAL RAILWAY LOCOMOTIVE.

to throw it in the form of "sparks" high above the chimney. By means of the draught the fire is kept burning fiercely, as it needs to be. You may look into the firebox while an engine is standing in a station, and the fire does not appear to be anything very wonderful. But see that same fire while travelling and when the blast is on; it is then one blaze of intense whiteness, far too bright for more than a passing glance.

There are, of course, many other parts of an engine: the *cab* where the driver and the fireman stand, and where all the various levers and valves and gauges are placed; the *tender* which carries the spare supplies of water and coal; the brake gear, lubricators, and various other fittings. But we have said enough to give an idea of how a steam locomotive engine is made, and why and how it works.



MODEL OF THE WALSCHAERT VALVE GEAR.

The Porter's Bank Holiday

A Recitation

"PORTER!" Yessir; train to Margit? Yessir, platform number three. Luggage? Yes, miss. Cab, sir, yessir. Made yer lose yer train, sir—ME?

No, sir, you're mistook, sir. "Porter!" Yes, miss. Lost yer ticket? Oh. Werry sorry, miss, but—Eh, sir? Where's yer box, sir? I dunno.

Fare to Bournemouth? Couldn't say, mum; there's the booking office. Hi! Cab there! Seen your missis? No I ain't, sir. You'll report me? WHY? Change a shillin'? No, I can't, mum. No, sir, mustn't cross the line.

"PORTER!" Yessir. Labels? Right, sir. Scotland: Yes, miss, platform nine.

Yessir. Eight-fifteen just gone, sir. London? Number six, sir.—Wot? Smokers full? Well, 'tain't my fault, sir. Scoundrel, am I? No, I'm not! Steamboat fare to Jersey? No, sir; couldn't tell yer. OUGHT to know.

Ought I?—Don't you swear at me, sir. Knock my head orf, will yer?—Oh!

"PORTER!" Yessir. Bill, this gent has left his luggage on the rack.

"Porter!" Yes, mum. Mind yer children? Yes, mum; hope you'll soon be back.

Three hours late your train, sir? was it? Traffic's werry thick, yer see. Write and blame the silly Comp'ny, 'tain't no good to bully me.

"PORTER," yessir. "PORTER!" No, mum! Right, sir! Oh, I'm orf my head.

These Bank Holidays is times when porters wish as they was dead!

From "A Jester's Jingles," by F. RAYMOND COULSON.

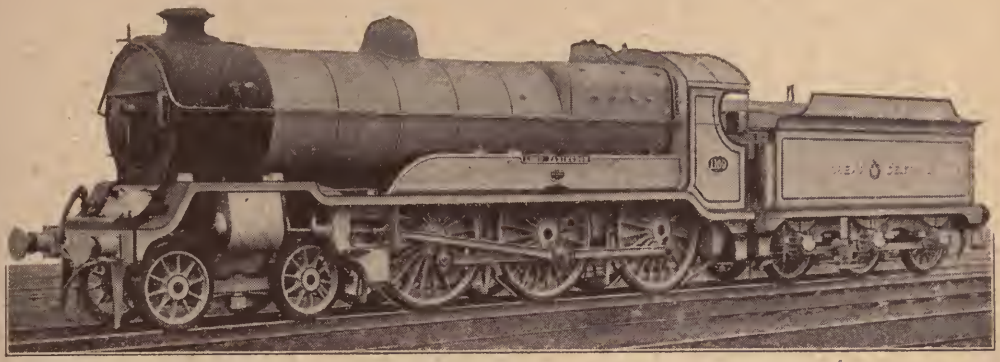
A MIDLAND 4-4-0 LOCOMOTIVE.

THE WETTERHORN AERIAL RAILWAY. [E. N. A.

The cables rise from the valley to a point some 7,000 feet up the flank of the mighty Wetterhorn, commanding, as can be judged from the photograph, magnificent views. The two cars act as counter-balances, one descending as the other ascends.

AMONG THE ROCKIES.

A Union Pacific train at the rail summit of the Continental Divide, Colorado, U.S.A. This pass is 11,660 feet above sea level, and is said to be the highest point reached by a standard gauge railway.



THE LORD FARINGDON.
A 4–6–0 Express Locomotive, Great Central Railway.

Express Passenger Engines

IN early days nearly all express engines had one pair of driving wheels only, the idea being that large wheels were necessary for fast running and that coupled wheels were not suited for high speed. Nowadays, however, much heavier loads have to be pulled, so that coupled wheels are used in order to obtain the necessary "adhesion," or grip, on the rails, as explained in the article "What Makes the Engine Go?"

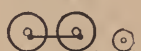
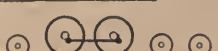
It used to be thought that "tied legs," as someone described coupling-rods, were unsafe and unsuitable for high speed; but although some of the old "single-drivers" reached speeds of about 80 miles per hour, it is common to-day for four-coupled and six-coupled engines to run much faster than this, of course on safe sections of the line and usually downhill.

Therefore, no single-wheel express engines have been built for many years. There are some still at work on the Midland, North Eastern and Great Central Railways, but they are only suited for certain duties. There were also four-coupled engines with a single pair of carrying-wheels in front, and many of these are still at work. But no engines of this class are built nowadays, and the ordinary express engines on all British railways are of what are known as the 4–4–0, 4–6–0 and 4–4–2 ("Atlantic") types.

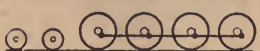
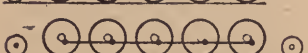
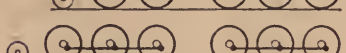
Before describing the engines a few words are necessary to explain what is meant by the "numeral system of classifying locomotive

types," otherwise, the application of the figures 4–4–0, etc., just mentioned.

For this purpose it is considered that every engine has wheels of three kinds, starting from the front, or chimney, end. First, there are carrying-wheels, either one pair, or a four-wheeled bogie. Next are the driving or coupled wheels, two, four or six as the case may be. Behind these are carrying-wheels, known as "trailing wheels." Thus, if you refer to the picture of the famous Great Western Railway engine No. 111, "The Great Bear," on page 14, you will see that it has two axles in front (four wheels) as a leading bogie; three pairs of wheels connected by coupling-rods (six-wheels-coupled); and a pair of small

	WHEEL DIAGRAM.	NUMERAL TYPE.
1		0–4–0
2		2–2–2
3		2–4–0
4		0–4–2
5		0–6–0
6		4–2–2
7		4–4–0
8		0–4–4
9		2–4–2
10		2–6–0 (*Mogul*)
11		0–6–2
12		0–8–0
13		4–4–2 (*Atlantic*)
14		4–6–0
15		2–4–4
16		0–6–4
17		2–8–0 (*Consolidation*)

EXPRESS PASSENGER ENGINES

	WHEEL DIAGRAM.	NUMERAL TYPE.	
18		0–8–2	
19		2–6–2	
20		4–6–2	(*Pacific*)
21		2–6–4	
22		2–8–2	(*Mikado*)
23		4–8–0	
24		0–10–0	
25		2–10–0	
26		2–10–2	
27		0–8–4	
28		0–4–4–0	*Articulated Types.*
29		0–6–6–0	
30		2–4–6–0	
31		2–6–6–0	
32		2–6–6–2	
33		0–8–8–0	
34		2–8–8–2	
35		4–4–6–2	

trailing carrying-wheels under the firebox. Therefore, we call this engine a 4–6–2, a very easy method of describing it.

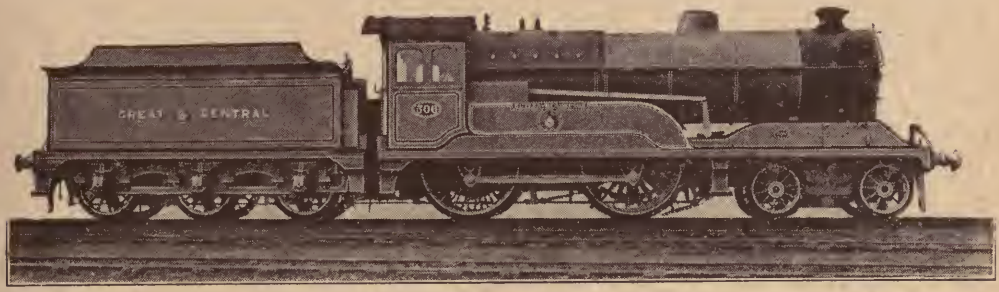
But if you look at other illustrations of engines there may be a leading bogie and six coupled wheels, but no trailing carrying-wheels. So for wheels which are not used we put a "nought," and say that the engine is 4–6–0. Other engines have no carrying-wheels in front, such as 0–4–2; while ordinary goods engines which have *all* their wheels coupled are 0–6–0. Whatever the arrangement of wheels, we can thus indicate it easily, and this convenient system is therefore used almost everywhere. On the Continent, engines are generally described according to axles, instead of wheels, so that a 4–6–2 becomes

a 2–3–1, or a 0–6–0 a 0–3–0. But the idea is the same. Many fanciful names are also used, some of which are mentioned in this and other articles.

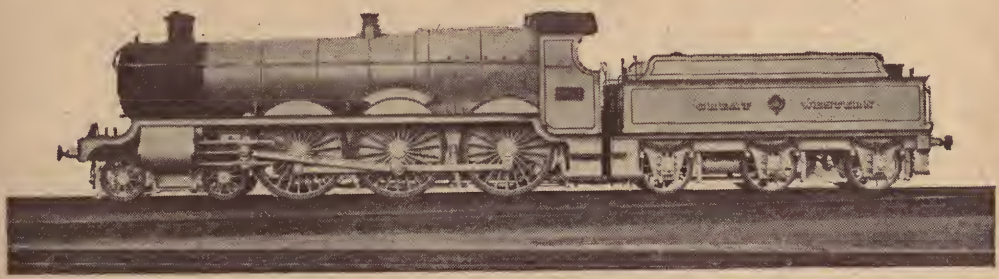
As there are no new engines of the 2–2–2, 4–2–2, 2–4–0 and 0–4–2 types, the first class to be considered is the 4–4–0, with leading bogie and four-coupled wheels, but no trailing carrying-wheels behind. These engines are very common; indeed, every railway has large numbers of them, many now getting quite old. On the London and North Western Railway there are the "George the Fifth," "Coronation," "Precursor" and other classes of these engines; on the Great Western Railway, the "City," "Flower," "Atbara" and many others. On the Midland Railway there are no bigger engines than 4–4–0, but some very fine work is done by the 1,000 class (three-cylinder compound) and by the superheater rebuilt 400, 500 and 990 classes, with two ordinary cylinders. On the South Eastern and Chatham and a few smaller lines there are no engines bigger than these; but on every railway the 4–4–0 engines work a great deal of the traffic, and often take most important trains.

In order to get a bigger boiler, we next have the 4–4–2 type, or, as it is known, the "Atlantic," a name which, like most of the fanciful names, came from America. In this there is a bogie in front, with four-coupled wheels, and a pair of small wheels to carry the firebox end of the boiler. The biggest "Atlantics" are those of the North Eastern Railway; they have three cylinders instead of two, one inside and two outside the frames. These engines work the very heavy Scotch trains between York, Newcastle and Edinburgh, and perform wonderful work. The most famous "Atlantics" are, however, those of the Great Northern Railway, though they are much smaller; many of these engines have what is known as a "Wootten" firebox, spread out over the frames instead of getting narrower below as in most other engines. And as the North British Railway, in Scotland, also uses big 4–4–2 engines it may easily happen that an East Coast express from King's Cross to Aberdeen will be worked by G.N. 4–4–2, London to Grantham; G.N. 4–4–2, Grantham to York; N.E.R. 4–4–2, York to Newcastle; N.E.R. 4–4–2, Newcastle to Edinburgh; and N.B.R. 4–4–2, Edinburgh to Aberdeen. Most "Atlantic" engines have the cylinders outside, but on the Lancashire and Yorkshire Railway they are inside. The Great Central Railway also has a large number of 4–4–2 engines, and a few of these have three cylinders. On the London,

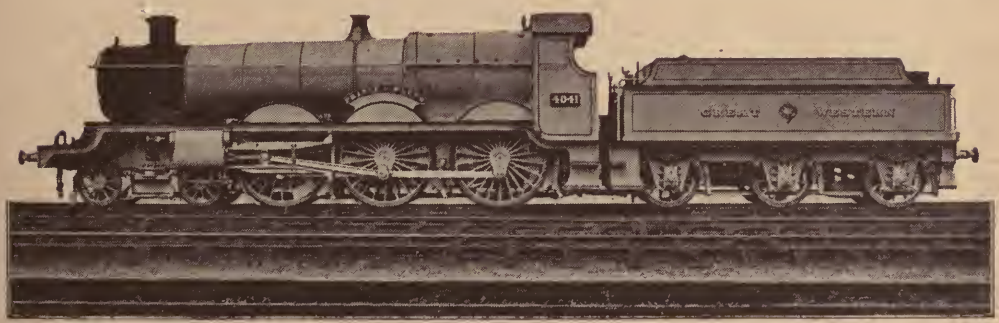
4–6–0 FOUR-CYLINDER EXPRESS LOCOMOTIVE, GREAT SOUTHERN & WESTERN RAILWAY, IRELAND.



FOUR-COUPLED EXPRESS LOCOMOTIVE, "BUTLER-HENDERSON," GREAT CENTRAL RAILWAY.



THE "BUTLEIGH COURT" (4–6–0), GREAT WESTERN RAILWAY.



THE PRINCE OF WALES (4–6–0), GREAT WESTERN RAILWAY.

Brighton and South Coast Railway some very fine 4–4–2's work expresses from London to Brighton, Eastbourne and Portsmouth; and on the Great Western Railway there are the three four-cylinder compound engines, No. 102 "La France," No. 103 "President" and No. 104 "Alliance," which were bought in France in 1903 and 1905 for trial purposes. These now have English boilers, so that they are half English and half French.

But the most important type of engine to-day is the 4–6–0, with leading bogie and six-coupled wheels. The biggest are the 4,000 class on the Great Western Railway, with four cylinders, and known as the "Stars," "Knights," "Kings," "Queens," "Princes" and "Princesses." These make the long journey of 226 miles without a stop from London to Plymouth, besides running many other important expresses to the West of England, to South Wales, and to Birmingham, Wolverhampton and Shrewsbury. There is also a class, not much smaller, with two cylinders only, known as the 2,900 class, and including the "Saints," "Ladies" and "Courts," besides many odd names such as "Albion," "Rob Roy," "Ivanhoe," etc. These do very nearly the same work as the 4,000 class.

On the London and North Western Railway the special 4–6–0 engines are the four-cylinder "Claughton" class; these work the Scotch

THE ABERDEEN EXPRESS CROSSING THE FORTH BRIDGE (NORTH BRITISH RAILWAY).

[F. E. Mackay.

GLASGOW-LONDON EXPRESS (CALEDONIAN RAILWAY).

expresses between Euston and Crewe, and Crewe and Carlisle, also running between London and Liverpool and Manchester with the heaviest trains. Besides these, there are some hundreds of two-cylinder 4–6–0's, the earlier ones being the "Experiments," and the later ones the "Prince of Wales" superheater class. These often work the chief expresses, though they are smaller than the "Claughtons."

The North Eastern Railway 4–6–0's are not generally used for the fastest express traffic, though there are a large number of them. On the Lancashire and Yorkshire Railway the 4–6–0 engines are more often used for heavy loads than for fast running. On the Great Central Railway there are many of these engines, one being the "Lord Faringdon," even larger than the famous "Sir Sam Fay" class. The latest 4–6–0 engines on the London and South Western Railway are also very big ones.

In Scotland the biggest express engines on the Caledonian Railway are 4–6–0, the latest being the No. 60 class. So that while by the

East Coast route from King's Cross to Aberdeen one may be pulled by 4–4–2's all the way, from Euston *viâ* the West Coast the engines may be all 4–6–0's: L. & N.W.R., Euston to Crewe, and Crewe to Carlisle, and Caledonian Railway, Carlisle to Perth and Perth to Aberdeen. The Glasgow and South Western Railway also uses 4–6–0 engines for its main line services, and on the Highland Railway 4–6–0's with rather smaller wheels work the heavy trains through the mountains between Perth and Inverness. One of the latest Highland engines, No. 51, "Clan Fraser," is illustrated below.

In Ireland nearly all express trains are worked by 4–4–0 engines, but on the Great Southern and Western Railway there is one big 4–6–0 engine, No. 400. This has done very fine work between Dublin and Cork and on Killarney expresses.

In other countries there are many engines much bigger than these, but in Great Britain we have only a solitary 4–6–2 engine used on a main railway. That is the famous "Pacific" (another American name) on the Great Western Railway, No 111, "The Great Bear"; although it is now ten years old it still stands alone. It has four cylinders and an enormous boiler, and is far bigger than any other express engine in this country. It generally works between London and Bristol, and frequently its high power is used to haul long and heavy goods trains.

Besides the engines mentioned there are a few other types which work express trains in places, but as these are not true express engines, they are dealt with in another article.

THE "CLAN FRASER" (4–6–0), HIGHLAND RAILWAY.

[*Topical.*

THE PATRIOT.

A "Claughton" type Express Passenger Engine, named in memory of London & North Western railwaymen who fell in the War. The engine is specially numbered 1914, and is japanned a dull jet black.

[*By courtesy of the Railway Gazette.*

THREE-CYLINDER EXPRESS GOODS LOCOMOTIVE, 2–6–0, GREAT NORTHERN RAILWAY.

This type was first used in 1920. It is capable of hauling a very heavy load at good speed.

[*By courtesy of the Railway Gazette.*

AN INTERESTING COMPARISON.

No. 1, the first of the 8-ft. single-driving wheelers, built in 1869, and a front view of No. 1000, the Great Northern Railway locomotive illustrated above.

THE "CORNISH RIVIERA" EXPRESS (Great Western Railway).

[F. E. Mackay.

THE "CORNISH RIVIERA" EXPRESS, HAULED BY THE "QUEEN MATILDA" (GREAT WESTERN RAILWAY).

Famous Expresses of all Countries

ALTHOUGH the centre of the greatest Empire the world has known, the United Kingdom is really quite a small country. But it is a very important one, with many big cities, a large population, and the finest railway system in the world, so that within its comparatively small area there is a wonderful series of express trains travelling every day in all directions. We can refer only to a few, for there are fast expresses, many making long non-stop runs, between all important cities.

The most famous express to-day is undoubtedly the "Cornish Riviera" of the Great Western Railway, which leaves Paddington every day to run without a stop to Plymouth, 226 miles—the longest non-stop journey in the world. But there are many other expresses, Great Western, London and North Western, Great Northern, Great Central, Great Eastern, London and South Western, nearly as notable, connecting London with Exeter, Cardiff, Brighton, Liverpool, Manchester, Leeds, Norwich and other big cities. There are also many important expresses to seaside resorts, such as those to Bournemouth by the London and South Western; the "Southern Belle" (Pullman

cars), and other "crack" trains of the London, Brighton and South Coast Railway; and the "Granville," "Cliftonville" and other expresses of the South Eastern and Chatham Railway (some now with Pullman cars); and the "Norfolk Coast Express" of the Great Eastern Railway.

Other railways, such as the North Eastern and the Lancashire and Yorkshire, have their "crack" trains, though they do not serve London.

In Scotland, besides the English express trains, there are the "Grampian" and "Granite City" expresses of the Caledonian Railway to Aberdeen, the "Lothian Coast" express of the North British from Glasgow to North Berwick, the "Golfer's Train" of the Glasgow and South Western, and the "Furthest North," for Wick and Thurso, of the Highland Railway.

Ireland has the Dublin-Belfast business expresses of the Great Northern Railway, the Dublin-Cork and Killarney expresses of the Great Southern and Western, and the "Limited Mail" of the Midland Great Western, all really fast trains, though English people do not usually hear much about them.

LIVERPOOL-NEWCASTLE EXPRESS, LANCASHIRE & YORKSHIRE AND NORTH EASTERN RAILWAYS.

EXPRESS TRAIN, BOMBAY, BARODA AND CENTRAL INDIA RAILWAY.

In the days before the War there were many fine expresses all over Europe. In France they were very good indeed; the "Orient" (for Constantinople), and the Trans-Continental expresses through Switzerland, Germany and Austria for the great cities of other countries, were often very fast trains, consisting of magnificent coaches. Among the special expresses were the "Brindisi Mail," the Simplon and St. Gothard expresses, the "Côte d'Azur," and other "rapides" and "trains-de-luxe."

Belgium, too, had its Trans-Continental expresses, with connections from London *viâ* Ostend; and Holland those from Flushing and the Hook of Holland. In addition, each country had its express trains between great cities, though in Great Britain little was known of them.

From Russia the famous "Trans-Siberian" express used to travel right across Siberia on its long journey of several days to Manchuria, for Japan and the Far East.

Asia includes many countries. China, Siam, Japan, and other old countries, have some very creditable expresses; but India has the most important. There we find the fast Bombay-Calcutta expresses, the "Delhi Mail," the "Poona Race Specials" from Bombay, and other trains almost, if not quite, as good. These usually have special cars, with ventilating fans, baths, and vehicles strange to

us, but rendered necessary by the hot climate. Some of the coaches need to be fitted up for native travel, with special vehicles for women, and carriages where Hindoos and others can travel without violating their religious ideas.

Australia has several big cities between which people require to travel regularly, but as each State has its own gauge of railway through expresses cannot often be run. Thus in travelling from Melbourne to Sydney passengers have to change trains at Albury, and each State runs its own train of special and very fine coaches to that point. The same occurs on other journeys ; but whether on 3 ft. 6 in., 4 ft. 8½ in., or 5 ft. 3 in. gauge lines, magnificent trains consisting of compartment, saloon, parlour, sleeper, restaurant and other cars are run. Then there is the Trans-Continental line across the great desert, opened for traffic in 1917. Trains run on this line three times a week. Between Port Augusta on the South Australian Railways and Kalgoorlie on the Western Australian lines, is 1,051 miles, but there are only thirty stations for all this distance, and some are over sixty miles (two are over seventy miles) apart. For 300 miles the line is absolutely straight, without a tree to be seen, while for the whole length of 1,051 miles there is not a single river to be crossed. The train includes first- and second-class sleeping-cars, restaurant cars and a lounge car fitted also as a writing room. A shower bath is available also. Telegrams can be sent or received at each station, and news is posted up in the cars as received by telegraph.

ONE OF THE SIX CYLINDERS OF A MAMMOTH AMERICAN LOCOMOTIVE.

This picture gives a good idea of the size of a single detail of the locomotive illustrated on p. 87. There are two high-pressure cylinders and four low-pressure. The size is 3 feet by 2 feet 8 inches.

In another article reference is made to the Cape-to-Cairo Railway, and to the Zambesi and other

[*Underwood & Underwood.*

A PICTURESQUE RAILWAY.

A train on the Northern Pacific Railroad passing the Pillars of Hercules, on the banks of the Columbia River, Oregon.

expresses concerned. South Africa has also its mail and other special trains of magnificent vehicles, travelling for 1,000 miles and more between Cape Town, Durban, Johannesburg, Pretoria and other towns. Though the gauge is only 3 feet 6 in., many of the coaches used are very large and handsomely fitted, while the speeds are very good considering the terrific gradients by which many of the trains cross the hill districts. Uganda, Nigeria, the Gold Coast, and other protectorates, also run very fine trains for white travellers.

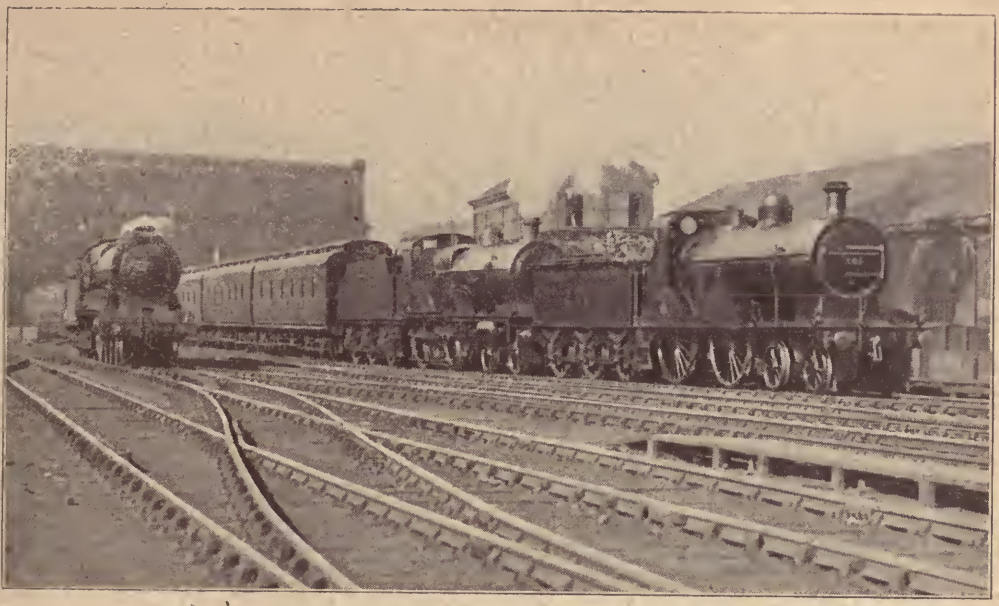
In North Africa there are some first-rate expresses between Cairo and Alexandria and other towns, while the Sudan Government Railways run a "Sunshine" express from Khartoum up the Nile on a route which may one day be connected right through to Cape Town.

It is now necessary to cross the Atlantic, first to North America. Here we find railways extending for ten times as many miles as those of our own country, but as the area is, perhaps, twenty times as great there are many parts where railways are few and far between, with trains running only once or twice a day to balance the busy lines in the manufacturing States. Between New York, Philadelphia, Boston

[*Sudan Government Railways.*

THE SUNSHINE EXPRESS.

This train runs between Halfa and Khartoum, Sudan Railway. Note the sun-blinds on the carriages.



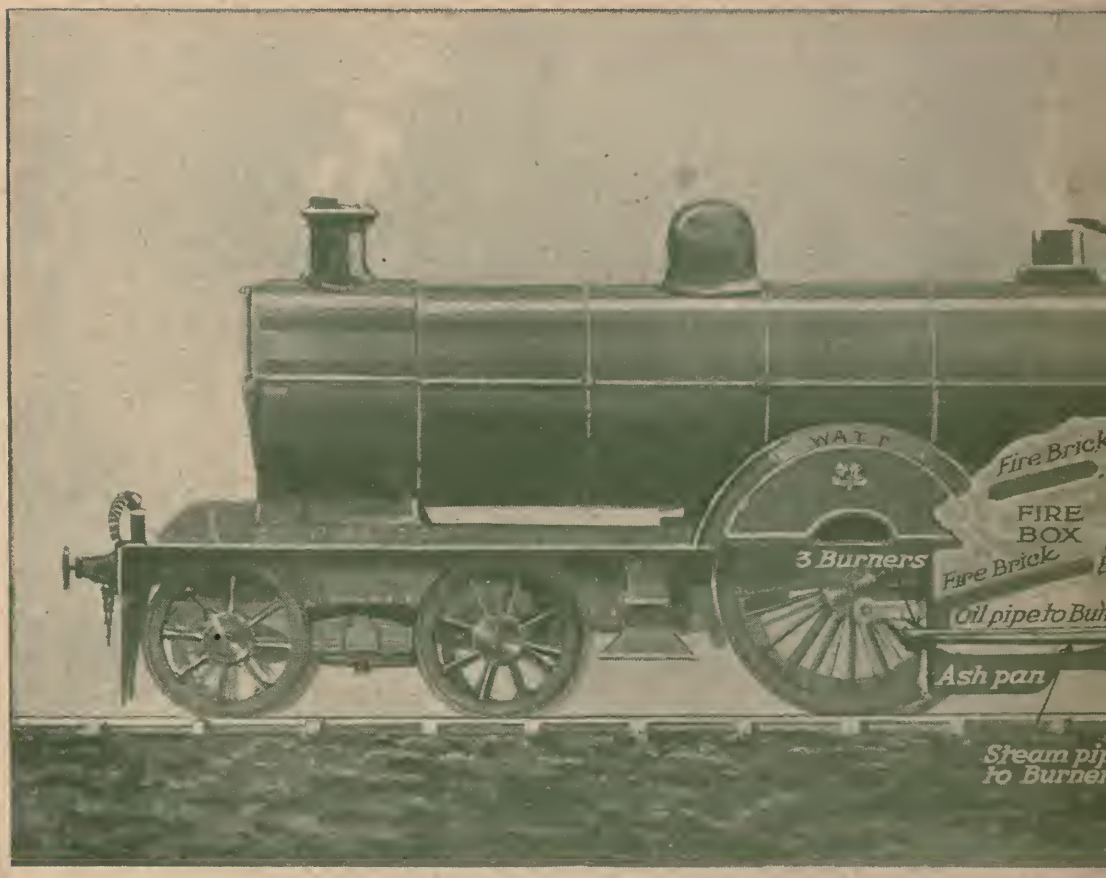
[*F. E. Mackay.*

SCOTCH EXPRESS LEAVING CARLISLE, MIDLAND RAILWAY.

and other towns not very far apart, there are dozens of express trains every day, and, both in the United States and in Canada, cities such as Washington, Pittsburg, Chicago, Buffalo, Quebec, Montreal, Ottawa, Winnipeg and hundreds of others are well served. Besides these, there are expresses between big cities a thousand miles or so apart, such as the "Pennsylvania Limited," the "Twentieth-Century Limited," the older "Empire State Express," and scores of others. Many have fancy names, such as "Katy Flyer," the "Olympian," and so on, and include splendid Pullman and other cars—drawing-room, parlour, lounge, sleeping, dining and the like, some of them travelling palaces on wheels, double the size of anything we have in Great Britain.

Then there are the great Trans-Continental expresses from New York to San Francisco, from Halifax to Vancouver, and so on. Some of these are in the United States; other routes are partly in the United States and partly in Canada, and others are wholly Canadian. These journeys of thousands of miles take several days, and whether in the United States or in Canada, involve crossing the Rocky Mountains, sometimes with one or more other mountain sections in addition.

While crossing the immense prairies and the wheat districts,

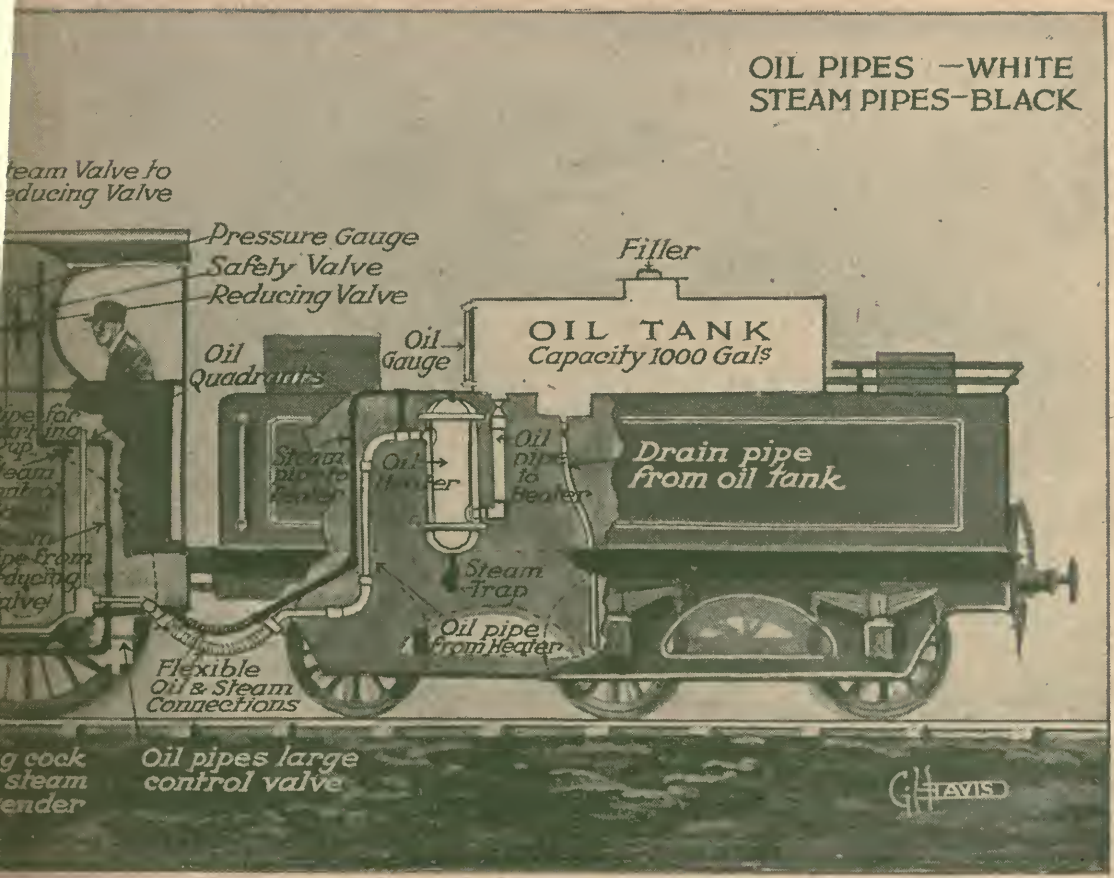


AN OIL-FIRED LOCOMOTIVE OF THE "PRECURS

In countries where coal is scarce and oil plentiful, as in South Russia, nearly all the locomotives are oil-fired. In C North Western Railway has recently experimented in the same direction. A locomotive consuming oil need carry only a tubes do not often require cleaning out, as there are no ashes to

speed is usually high, but in the mountains the lines are carried over high viaducts and trestles, through dark canyons and gorges, by dizzy precipices, necessarily at slower speed owing to the terrific grades which the powerful engines have to surmount. The scenery is magnificent, and many of these journeys could well be made for pleasure alone. But it is business that accounts for the making of these great Trans-Continental lines extending from the Atlantic to the Pacific; and the through trains are real expresses and include vehicles fitted up in a way which makes travel quite delightful.

South America, too, has its expresses, with sleeping and dining cars and all the conveniences of travel, from Buenos Ayres, Rio de Janeiro, and other cities; while if through trains are not run across



YPE, LONDON AND NORTH WESTERN RAILWAY.

ritain, the Great Eastern Railway many years ago had a number of locomotives fitted to burn oil, and the London and alf the weight of fuel required by a coal-burning engine. Moreover, steam can be raised twice as quickly, and the boiler em. The chief difficulty, at present, is in obtaining oil fuel at a moderate cost.

the Andes one can make the journey by rail from Atlantic to Pacific by using the Antofagasta and Bolivia and Trans-Andine Railways. Both cross the Andes very high up, for there is no way through, and use rack engines on the very steep sections, while the Trans-Andine Railway, at its loftiest point, reaches the tremendous height of 16,000 feet above sea-level.

Other countries, such as Cuba, Mexico, and even far-away Alaska, besides Norway, Sweden, Denmark, Spain and Portugal, which have not been mentioned, have expresses of some sort. But enough has been said to show that express trains are to be found wherever railways have been made, many of them famous, and all useful and highly valued.

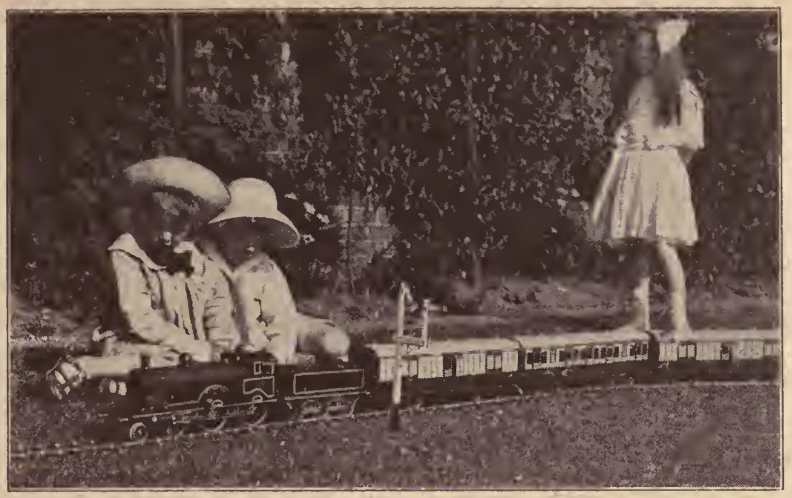
THE L. & N. W. RAILWAY OIL BURNING LOCOMOTIVE "WATT." [*F. E. Mackay.*

Another view of the engine illustrated in section on pp. 40-41 Note the oil tank on the tender.

[*W. W. Stewart.*

THE ROTORUA EXPRESS.

This is a very popular train to the wonderland of hot springs and geysers, some 170 miles from Auckland, New Zealand. The train being very heavy, and having some steep gradients to negotiate, is usually drawn by two engines.



[*Fleet Agency.*

A 2½-GAUGE MODEL LONDON & NORTH WESTERN RAILWAY TRAIN.

The Concert Party

POOR little Peter had been invited to a picnic. You can see that he has his best things on, white cap, white jersey, white 'bockers (that's what Peter called them), white shoes and socks ; and then, after the trouble of dressing, and all Nurse's scolding because he wouldn't stand still, the rain came pouring down, and poor Peter couldn't go to the picnic at all. The worst of it was that he was sick and tired of his toys ; he hadn't a single one that he felt the least interest in—and as for his books, well, they were all right, but who can sit down quietly and read a book when the unkind rain has spoilt a picnic ? Not Peter anyhow. He stamped round the nursery in a rage, and it was a very good thing that Nurse wasn't there, or there would have been trouble. At last, when he was tired of stamping, he threw himself down at full length on the window seat and lay watching the rain, coming down like long steel rods straight from the grey clouds.

All of a sudden he heard a voice at his elbow, a funny little voice that sounded like two bits of stick being grated together.

"I should like to know how we're a-goin' to get to this 'ere concert," it remarked. "Here's me and Nigger and Dutch—three of us—and not a taxi to be seen."

Peter started up and saw it was his Chinese doll "Chang-pu" that was speaking. Chang-pu, by the way, had associated with very common dolls before he entered Peter's family.

"Well, you'll have to give the concert up," said Peter. "I've had to give my picnic up. It's a jolly nuisance, but one must just grin and bear it."

"Grin and bear it indeed!" retorted Chang-pu, "is that what you call stamping round the room and kicking your toys about? In any case it's a long sight worse for us. Me and my mates are giving the concert, and if we ain't there, well, there won't be no concert, that's all."

Peter thought for a little while, then he said, "How far is it?"

Photos by] [*W. H. Bunnett.*

"I'LL TAKE YOU THERE IN MY TRAIN,' SAID PETER.

"Oh, a goodish step," replied Chang-pu. "The concert is to take place on that small table yonder, over agin the harmchair."

"If you like I'll take you there in my train," said Peter.

"Oh, that would be just sweet of you," exclaimed Nigger, a nice little black-faced dolly in a striped frock.

"We should *love* it!" cried Dutch, who was also standing by. "You see I play the piano, so they can't have any singing unless I'm there."

Peter jumped down from the window-seat to get his train. It was

"THE CONCERT WAS A GREAT SUCCESS."

right at the bottom of the toy-cupboard, tangled up with all sorts of things, and he broke a horse and cart and the sails of a toy windmill in dragging it out.

"I'm afraid it's too small for all of us," said Dutch. "You see we've got our best frocks on and they mustn't be crushed. Haven't you a larger conveyance?"

"Well, I can hitch my motor wagon on behind," said Peter. "There will be plenty of room then."

"PETER UNHITCHED THE ENGINE, AND TOOK THEM HOME IN THE MOTOR WAGON."

"Right oh!" replied Chang-pu. "That will do a treat, but look sharp, there's a good chap. Every moment is precious."

Peter did look sharp, and when he wheeled up the wagon and coupled it to the engine, the dolls seemed quite satisfied. Chang-pu got inside the wagon, while Nigger sat astride the bonnet, and Dutch had quite a comfortable seat on the engine, where she could spread her long legs out in front and not crush her frills at all. Peter took his place at the back of the wagon, and, making puffing noises with his mouth, got them all along in fine style, so that they reached the concert two minutes before the time.

The principal singer was a funny-faced old gentleman with a small cap on the side of his head, and he sang "Three Blind Mice" with so much feeling that large tears ran down Chang-pu's face. Peter obliged with three lines of "A Frog he would a-wooing go," all he could remember, and Chang-pu sold the programmes. The whole concert was a brilliant success, and when the time came to go home, they invited several friends to go too, because they did not mind crushing their frocks now the concert was over. So Peter unhitched the engine and took them all home in the motor wagon. He had just arrived safely with his load at the nursery cupboard when Nurse opened the door and said:—

"It's left off raining now, Master Peter, and so you can start to the picnic after all." Peter looked at her in surprise, for he had really been enjoying himself so much, he had forgotten about the picnic altogether.

JESSIE POPE.

A GARDEN MODEL RAILWAY IN INDIA.

[*Sport and General*

PILES OF LUGGAGE AT CHARING CROSS STATION.

Twice Round the Clock

MOST of us think of the day as the time for work and of night as the time for rest; but to railwaymen employed in a busy district the day is at least twenty hours long, and often covers the whole twenty-four hours. At all times trains are travelling with goods and coal, if not with passengers, and nearly all the big stations are open day and night. Great junctions are often as busy after midnight as at any time in the day, for the long-distance trains which leave London or Scotland in the evening have to be dealt with at Crewe and Carlisle, or at York and Newcastle, while most of you are asleep in bed.

Besides these trains are many others, some for milk, parcels, and other traffic, which do not convey passengers at all, and these keep the big termini busy during the hours when ordinary travellers are few, so that all day and all night there are men on duty and hard at work.

The railway day is, indeed, "twice round the clock," though, of course, the same men are not working all the time. Most of them now

AN OVERHEAD PARCEL CARRIER, VICTORIA STATION, MANCHESTER, LANCASHIRE & YORKSHIRE RAILWAY

On a busy station much time and jostling can be saved by carrying luggage overhead in the manner illustrated. The "traveller" is worked by an electric motor.

work eight hours, and the usual duties are from 6 a.m. to 2 p.m., from 2 p.m. to 10 p.m. and from 10 p.m. to 6 a.m. Some men keep regularly to the same hours, working always either night or day, but as a rule they work these duties in turn, or have two weeks day work and one week night work.

As midnight strikes the last long-distance train will usually have left a great city terminus, and for some little time two or three local trains for passengers are the only ones visible. But trains of parcel vans, and perhaps of fish, vegetables, fruit and other articles which are not dealt with at the goods stations, will put life into a terminus even at 2 or 3 o'clock in the morning.

Then there are usually a few local passenger trains bringing early workers at the markets to work, or taking home newspaper men who have been busy preparing and printing the newspapers for the next morning. In fact, in every great city there are thousands of workers of one kind or another who require trains in the early morning. And about 2.30 or 3 a.m. there is generally at least one train to be sent

LEEDS AND BRADFORD LUNCHEON CAR EXPRESS (Great Northern P .way).

The locomotive is one of the famous "Atlantics" of this line. The train has just emerged from Hadley Wood Tunnel.

off with early-printed newspapers to be sold to people in towns 150 or 200 miles away as they go to business, or delivered at their houses before breakfast.

About 5 o'clock the workmen's trains begin to arrive, and until 8 o'clock nearly all the local passengers travel with cheap workmen's tickets. Early traffic is not quite so heavy as it used to be, now that so many workers do not start work until 7 or 8 o'clock instead of 6 o'clock; but the trains are still numerous and busy. Soon after 5, too, the first long-distance train is usually sent off, and this has always a lot of parcels and similar traffic, and often conveys a good number of passengers. From this time onward the long-distance expresses which have been travelling all through the night begin to arrive and that part of the station becomes very busy.

From 8 until 10 o'clock ordinary season-ticket holders are coming into town for business as quickly as the trains can bring them. Every platform is busy, as train after train runs in and unloads perhaps

[*Alfieri.*

A QUEUE OF HOLIDAY-MAKERS WAITING FOR TRAINS AT WATERLOO STATION, LONDON.

PASSENGERS' LUGGAGE AT TALBOT ROAD STATION, BLACKPOOL, IN THE HOLIDAY SEASON.

a thousand passengers, many going back empty for another load as soon as they can. Meanwhile, sets of carriages for long-distance expresses are being brought into the main-line platforms; and from 9 until 11 these are loading up, luggage brought by taxis is labelled and placed by porters in the vans, newspaper boys and refreshment trolleys pass up and down the platform to serve passengers, and all is bustle. There are business men travelling to other towns; people travelling for pleasure; happy families off to visit relatives or perhaps on the way to the seaside for a holiday; soldiers and sailors and all kinds of people going to many different places and for many different reasons.

From 10.30 a.m. until 4.30 p.m. the suburban trains are less frequent, and while there are always many passengers there is none of the rush and bustle which occurs later. That is, provided it is not Saturday. Then, from soon after 12 until about 3 o'clock the station is very busy indeed, for thousands of workers all want to be taken home at the same time, and there are, besides, hundreds who are going out into the country, or up the River for the afternoon.

During this time trains are sent off as quickly as they can be brought in and loaded, and every platform and every part of the station is alive with people. From 1.30 until 3 o'clock there are also the afternoon expresses for various places. These are busy on an ordinary day, but on Saturday they get extra traffic; people going away for the week-end, off for a holiday, paying visits, or perhaps going to homes which are too distant for them to come to and from town except at week-ends.

Then on an ordinary day from 4.30 until after 7 there are the home-going season-ticket holders, and the station is as busy as it can be getting them away. Perhaps thirty or forty trains will leave in each hour, but the crowd seems as great as ever. At last, however it eases off, and the station settles down to a few hours of lighter traffic.

From 5 o'clock there is a further set of expresses, and some of these are the fastest in the day. Business men do not want to waste working time in travelling, and so, after spending the day at their offices, they leave by these expresses, dining on the way, and reaching Liverpool, Manchester, Leeds and other big towns about 10 o'clock The night is spent at a hotel and next morning they are ready to do business with people in those towns during their ordinary working hours.

ANOTHER VIEW OF THE OVERHEAD ELECTRIC PARCEL CARRIER, VICTORIA STATION, MANCHESTER.

But some towns are too far away to be reached the same evening, so that from 7 o'clock until midnight there are long-distance expresses with sleeping cars travelling through from London to Scotland and other places. Earlier ones go through to Aberdeen and Inverness, or connect with steamers for Ireland; but passengers do not want to be landed in Edinburgh or Glasgow at 4 or 5 o'clock in the morning, so they go by the later ones about 11 o'clock.

Then from 11 o'clock until midnight or soon after, suburban residents who have spent the evening in town, and some late workers, are going home, and for a little while the station is again fairly busy.

Finally, trains leave about midnight for towns 200 miles or more away, and these take a lot of parcels and similar traffic, for they call at several important stations on the way, as they need not be so fast as the earlier trains for the same places. They arrive by 6 or 7 o'clock in the morning, in time for passengers to have breakfast and then to see about their business, having obtained what sleep they could in the train.

In the evening there are also the mail trains, some for post-office purposes only, with letters and parcels; others taking passengers as well.

So it will be seen that from midnight to midnight there is always something going on, and employees are never absent from duty somewhere about the station.

THE DRIVER.

The Lost Lunch

Photo] "HE HAD SOME TIME TO WAIT." [*W. H. Bunnell.*

BOB'S people gave a picnic
One fine September day,
They started off at ten o'clock,
Their hearts were light and gay.
But Bob's, alas, was full of woe
Because they would not let him go.

He watched them from the window,
Mamma turned back to wave.
He rubbed his eye, but would not cry
Though one deep sigh he gave;
Then, later went downstairs to find
They'd left the lunch and tea behind.

THE LOST LUNCH

Bob didn't waste a minute,
A taxi-cab he called,
The hampers with the lunch and tea
Into that cab he hauled.
"Drive to the station!" to the man
He said, "as quickly as you can."

He took a third-class ticket,
But had some time to wait,
So sat upon the lunch and tea
As if enthroned in state.
But in the end, with smiling face,
He safely reached the picnic place.

His people were delighted,
They cheered till they were hoarse.
Mamma *was* glad; "her little lad
Must stay," she said, "of course."
The hero of the day was he
And had a splendid lunch and tea.

JESSIE POPE.

THE MINIATURE RAILWAY FROM BARMOUTH FERRY TO FAIRBOURNE.

In the holiday season this little line meets a real need, and is very popular. Often as many as half a dozen cars are put on. The "Atlantic" locomotive weighs 1¾ tons.

AN INTERESTING COMPARISON.

The "Rocket" against the "W. C. Brocklehurst," a 4-4-0 engine of the Coronation class, London & North Western Railway.

The First Locomotives

IT was known quite 2,300 years ago that steam possessed the power to set things in motion; for in a book written in 384 B.C. it is said that earthquakes are caused by the sudden turning of water into steam. But more than twenty centuries passed before men found out how to shut up steam in a round iron box, called the cylinder, in such a way as to give movement to a rod, or piston, connected with wheels.

Steam engines of a very rough and ready kind were in use early in the eighteenth century; but it was James Watt whose patient study of the subject, from 1763 to 1768, resulted in such great improvements in the machine that he is rightly looked upon as the inventor of the steam engine.

Not yet born, however, was the locomotive—that is a steam engine placed on wheels for the purpose of moving loaded carriages and wagons along a railway. Sixteen years after Watt had produced the improved steam engine, his assistant, William Murdock, invented and made at Redruth, in Cornwall, the first English locomotive. It was little more than a toy, supplied with heat by a spirit lamp beneath, and with the large, or driving, wheels only 7 inches in diameter; but when Murdock set it moving along the road, in the presence of a wonder-

ing crowd, in 1784, he had succeeded in constructing a locomotive and in making his name remembered for ever.

Twenty years later there was a scene of great excitement in South Wales when Robert Trevithick, after many experiments, made trial of one of his engines designed to drag along rails, at the tremendous rate of five miles an hour, wagons heavily laden. In a Bristol newspaper, dated March 3, 1804, we read the following account :—

"On Tuesday last a trial was made of one of Mr. Trevithick's steam engines at Merthyr Tydvil, for the purpose of finding what its powers were in drawing carriages; and it was found to perform to admiration all that was required of it. In the present instance it was made use of to convey along the tramroad ten tons of iron from Penydarren Ironworks to the Glamorganshire Canal, upwards of nine miles distant; and it is necessary to observe that the weight was soon increased by about seventy persons riding on the wagons, who, drawn thither by curiosity, were eager to be the first people in the land to be carried by the power of steam. The engine travelled with ease at the rate of five miles an hour."

A year later Trevithick improved on this machine and showed at Euston Square, London, an engine which ran on a circular railway. On that day the public, at a charge of one shilling per head, had the opportunity of riding on what may be considered the first train carrying fare-paying passengers.

This ingenious inventor's first attempt at constructing a steam carriage was made in 1802 and went by the name of the "Puffing Devil," or Captain Dick's Puffer. There is a model of it in the Victoria and Albert Museum, London.

People wondered when they saw these first attempts at steam locomotion, snorting and snarling and puffing along with great difficulty; and they called the engines "madmen's toys." Few believed that these steam engines would ever travel fast, or cover long distances, or draw heavy loads; and rich men for years positively refused to waste, as they thought, their money in making railways. But all this time there was a wonderful man living in the North of England who laboured with might and main to make railway travelling successful, feeling sure that, with thought and patience, every difficulty would at last be overcome. His name was George Stephenson.

This remarkable man, the son of a labourer at Wylam Colliery near Newcastle-on-Tyne, was born on June 9, 1781. His father,

who had six children to support, and earned only 12*s.* a week, was not able to send any of his family to school, and it was only by attending an evening school, when he was twenty years of age, that George was able to read and write. As a boy he looked after the cattle, his wages being 2*d.* a day ; later, he received 4*d.* a day as a hoer of turnips, and in his early manhood he was nothing better than a labourer in a colliery yard. Yet in time he became England's greatest engineer and the most famous of railway-makers.

[*Illustrations Bureau.*

THE FIRST LOCOMOTIVE MADE IN ENGLAND.
Invented and constructed at Redruth, Cornwall, by William Murdock in 1784.

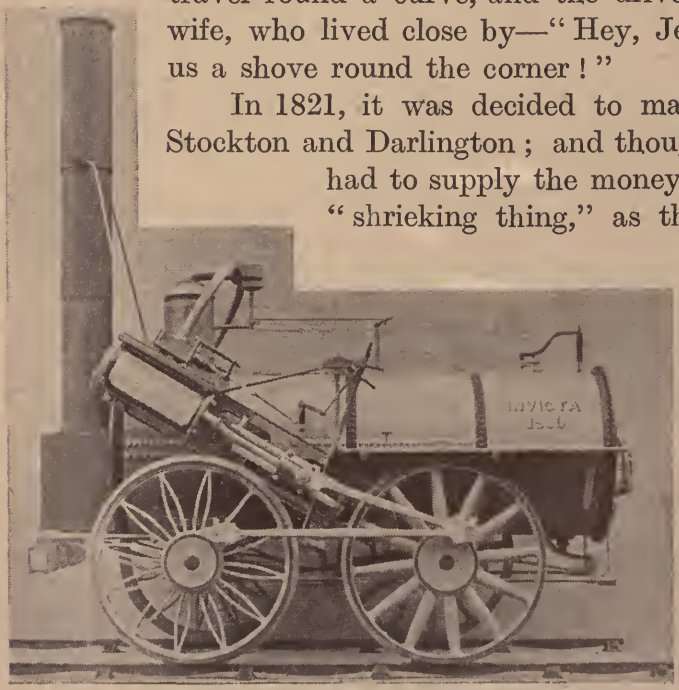
George Stephenson had to work very hard and to endure much before he won any success. He had a blind father and a helpless mother to support ; and as the wages he earned in the colliery yard were very small he was obliged to spend his evenings in mending clocks and watches, making shoes, and cutting out suits of clothes. But amid all his labours he kept earnestly thinking out a plan by which

he could construct an engine that would draw loaded wagons across the colliery yard ; and at last his patient strivings were rewarded with success.

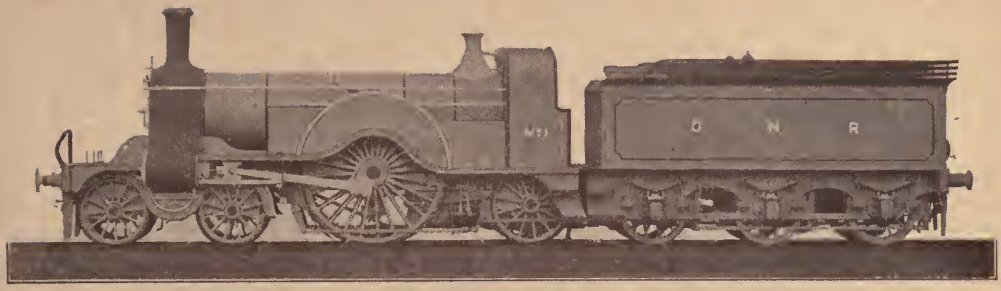
In 1814 an engine, built by George Stephenson, was placed on the tramway at Killingworth Colliery in Northumberland, and succeeded in drawing, at the rate of four miles an hour, eight wagons laden with coal. Stephenson, in spite of this success, kept on trying to do better, and in the following year made an engine which travelled at double the speed. Lord Ravensworth, the owner of the colliery, supplied the money, and people said of him, "A fool and his money are soon parted." Lord Eldon, one of the wisest of Englishmen, wrote, "I am sorry to find that the intelligent people of the North Country have gone mad on the subject of railways."

But still George Stephenson laboured bravely on, not frightened by difficulties, not troubled at all by those who laughed at him. His first engine on the Killingworth Colliery railway was named "Blucher" ; and those who were not willing to believe that railways would ever succeed were amused and at heart glad when the engine could not travel round a curve, and the driver had to shout to his wife, who lived close by—"Hey, Jean, come oot, and gie us a shove round the corner !"

In 1821, it was decided to make a railway between Stockton and Darlington ; and though many of those who had to supply the money hesitated to use the "shrieking thing," as they called the engine, and would rather have had the carriages drawn by horses, it was at last decided to have a locomotive and to employ George Stephenson as engineer. Speaking to his men, at the time when the line was being made, George said—"Now, lads, I venture to



THE "INVICTA."
Used at the opening of the Canterbury and Whitstable Railway in 1830.



THE FIRST OF THE 8-FT. SINGLES, BUILT IN 1869 FOR THE GREAT NORTHERN RAILWAY.
Another illustration on p. 32 shows this engine alongside the 2–6–0 Express Goods Locomotive No. 1000.

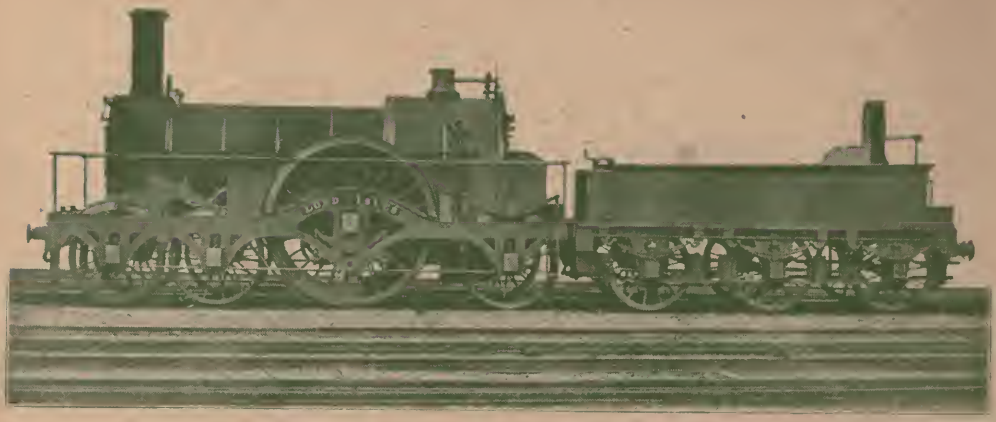
tell you that I think you will live to see the day when railways will take the place of almost every other method of conveyance in this country—when mail-coaches will go by railway, and railways will become great highways for the king and all his subjects. The time is coming when it will be cheaper for a working man to travel on a railroad than to walk on foot."

The Stockton and Darlington Railway, which cost a quarter of a million of money to make, was opened with great rejoicings on September 27, 1825. George Stephenson acted as driver on this great occasion, and his engine, which was called "Locomotion," worked splendidly; for though the chimney became nearly red-hot during the journey the boiler was on its best behaviour and did not burst—a fact which surprised many of the onlookers. The event was thus described in a newspaper of the time:—

"The signal being given, the engine started off, drawing six loaded wagons, a passenger carriage and twenty-one trucks fitted with seats. Such was its velocity that in some parts the speed was twelve miles an hour. The number of passengers was counted to be 450, which, together with coals and other things, would amount to nearly thirty tons. The engine with its load did its first journey of eight and three-quarter miles in five minutes over an hour."

The "Locomotion," which began its work so well, was in active service for twenty-one years, performing its last journey on the opening of the line from Middlesbrough to Redcar on June 4, 1846, doing the distance of close upon eight miles in twenty-five minutes. It is still to be seen on a pedestal at Darlington station.

A few years later the famous "Rocket" engine was built; and of a kind similar to the "Rocket" was the "Invicta" locomotive which was used on May 3, 1830, at the opening of the Canterbury and



THE LORD OF THE ISLES.

One of the famous broad gauge single-wheelers formerly used on the Great Western Railway.

Whitstable Railway and is now kept in the Dane John park at Canterbury.

George Stephenson's success made the traders in great towns wish for the help of the locomotive to quicken the speed and lessen the expense of transport; and it was decided to give the great engineer the work of making a railway between Liverpool and Manchester. The difficulties were very great. There was much trouble in getting the necessary consent of Parliament, and the landowners around hated the very name of a steam-engine. Stones were thrown, and even guns fired at the workers; and one railway surveyor had to pay a prize-fighter to carry his surveying instruments to protect them from destruction by the angry people who looked on.

We are even told of a clergyman who objected to a railway being made in a certain part because he was sure that the congregation would rush out of church in the middle of his sermon when they heard a train passing. Perhaps his sermons were not very interesting.

Dr. Smiles, in his *Life of George Stephenson*, which every boy should read, wrote:—

"Pamphlets were written and newspapers were hired to revile the railway. It was declared that its formation would prevent cows grazing and hens laying. The poisoned air from the locomotives would kill birds as they flew over them, and make the preservation of pheasants and foxes no longer possible. People were told that their houses would be burnt up by the fire thrown from the engine chimneys, while the air around would be darkened by clouds of smoke. There would no longer be any use for horses. Boilers would burst and blow passengers to atoms."

It was at this time that George Stephenson made his famous remark about the engine and the cow. Someone said to him—"Suppose, now, one of these engines to be going along a railroad at the rate of nine or ten miles an hour, and that a cow was to stray upon the line and get in the way of the engine, would not that be a very awkward circumstance?"

"Yes," replied Stephenson with a smile, and speaking in his rough Northumbrian style, "very awkward indeed—*for the coo!*"

At length permission was obtained to make the Liverpool and Manchester Railway, and when it was opened on September 15, 1830, in the presence of the great Duke of Wellington, George Stephenson acted as driver for the first journey on an engine which was called the "Northumbrian," because it was in the county of Northumberland that the triumphant engineer was born. Eight engines took part in the procession, one of them being the "North Star," built by George Stephenson's son, Robert.

W. R. R.

A FULL SIZE MODEL OF STEPHENSON'S "ROCKET" ALONGSIDE A LONDON & NORTH WESTERN PASSENGER ENGINE OF THE "GEORGE THE FIFTH" CLASS.

[*Fleet Agency.*

THE "DE WITT CLINTON," THE FIRST STEAM RAILWAY LOCOMOTIVE RUN IN THE STATE OF NEW YORK. She made her first journey in 1831, and attained a speed of 15 miles an hour.

The First Railways

GEORGE STEPHENSON'S triumph in the making of the Liverpool and Manchester Railway, and the success of the undertaking, made other towns anxious for the blessing of a railway, and those who had been most scornful about the locomotive began to sing its praises. The Liverpool merchant who had said in public, "If ever an engine can be made to travel more than ten miles an hour I will eat a stewed engine wheel," thought well to forget his rash promise when he saw George Stephenson's "Northumbrian" speeding away to Manchester at the rate of twenty miles an hour. In the next few years many railways were laid down.

In those early days, of course, railways were very different from those of to-day. The station in remote parts was often little better than a shed, at which for hours the porter in charge had little else to do but yawn. In some districts the line was chiefly used for minerals, with a carriage or two hooked on for passengers; and it sometimes happened that when a traveller reached a station after the train had started he would be cheered by the encouraging words of the station-master, "Be quick; she's not long gone; if you look sharp you'll catch her up!"

On one line in particular the trains were so slow that comical pictures were printed making fun of the railway. There is still to be seen a sketch of a costermonger seated in a barrow drawn by a donkey, running a race with a train and beating it; and another showing an engine-driver asleep on his tender while the train is being pulled along the line by a donkey.

Even the unhappy passengers were laughed at by artists who thought it amusing to watch worried people who were taking what was perhaps their first journey on the railway. In one drawing we are shown the troubled condition of a lady who on entering the railway carriage counted and re-counted her parcels in great distress, and at last cried out in despair, "Goodness me! I've forgotten the baby!"

But while many people laughed, the railways flourished, and every year witnessed some improvement. What the early engines were like we have already shown; what the whole train looked like you can see by other illustrations. Each carriage was given a special name, as in the old coaching days; and you will notice that even those of the second-class were open at the sides, the only protection at the top being a rough awning, which was in the habit of taking a journey in the air when the wind was strong. The first-class train was more comfortable, for there were cushions on the seats, and the carriages were entirely covered in.

But all the same, even the first-class train must have been a comical sight with the very high funnel of its snorting, puffing engine;

[From a print lent by the London & North Western Rai'way.

AN EARLY LOCOMOTIVE TAKING IN WATER AT OLD PARK SIDE STATION ON THE THEN LIVERPOOL & MANCHESTER RAILWAY.

the roof of every one of the rattling, bouncing carriages heaped with luggage ; a gay-looking guard in a scarlet jacket perched on the top of the front carriage ; and at the back of the train, on a truck, a family carriage filled with people enjoying the new experience of travelling in their own coach without the help of horses.

In the first time-table printed by the Grand Junction Railway (which afterwards became part of the present wonderful London and North Western Railway) the Company were kind enough to give not only the times of the trains and the fares, but advice to passengers as to how to behave if they wished to ride safely ; and they also provided in the time-table some pleasant reading about a journey by train.

In this strange kind of time-table we read—

THE FIRST RAILWAY TRAIN IN THE ARGENTINE REPUBLIC.

" If you wish to see well take your place outside. You will want an extra great coat, and a pair of gauze spectacles to keep the dust and smoke out of your eyes ; but in all other respects you will enjoy the time more than your fellow travellers. I shall suppose you mounted on the box seat. You look round and see several engines with red-hot fires in their bodies, and volumes of steam issuing from their tall chimnies. One of them moves slowly towards you. The huge creature bellows at first like an elephant. Deep, slow, and terrific are the hoarse heavings that it makes.

" It passes by your train of carriages, and, going to the head of them, slips from one line to the other, and backing to the train, is fastened to it. There it is, roaring, groaning, and grunting, like a sea-horse, and spouting up steam like a whale. You feel a deep, strong, tremulous motion throughout the train, and a loud, jingling

A NEW YORK—CHICAGO EXPRESS.

The train is being hauled by two of the largest and most powerful Pacific-type locomotives. It is climbing the famous Horse-Shoe Curve in the Alleghany Mountains, Pennsylvania.

THE FIRST TRAMS IN LONDON—LAID DOWN IN 1861, FROM THE MARBLE ARCH TO SHEPHERD'S BUSH.

rattle is heard. The conductor has done his part and is seated; the guard is in his box at the back of the first carriage; a bell is rung as a signal for starting—and you are off.

"At first you go very gently, and hear the engine rushing and plunging; gradually your pace quickens, and before half-a-mile is passed over, you find you are going at a speed which outstrips the fastest coach. The rattle of the engine now settles down to something like the clatter which takes place in a flour mill. At first you can keep pace with the stroke of the piston by the play of the fingers; but, as you proceed on your journey from Birmingham to Liverpool or Manchester, you find you cannot do it; nor would the most clever pianoforte player be able to do so.

"The country opens rapidly but beautifully, and the scenes shift and pass away as if by magic. The engine before you seems to be some extraordinary animal which, with the strength of the elephant

[*Print supplied by Great Western Railway.*

A LOCOMOTIVE DRAWING PRIVATE COACHES AT ABINGDON ROAD STATION (1844).

A GOODS TRAIN IN 1837.

and the swiftness of the eagle, has the power of impelling itself forward at a great rate, while it hurls the world away behind it. A village or a small town is passed like a watch-box on the road. You have the feeling of the most perfect safety, and the rapidity of the motion is delightful. You are never sensible of the swiftness of the movement until you meet another train; which you can only notice by a rush, a kind of shadow which passes and is gone before you are aware.

"To those who are inside, the pleasure is complete while they do not look out; for so gentle and composing is the movement that most persons are inclined to sleep, especially when the stoppages are few, as is the case with the first-class trains. As the passengers feel perfectly secure, many of them sleep soundly the whole distance from Birmingham to Liverpool. When the train stops, the power of the engine is suddenly taken off. The impetus which has been given to the train is opposed by 'breaks' applied to the wheels, and in a few hundred yards the train, from moving at the rate of twenty miles an hour, stops as quickly as a coach. One long and loud creak is heard and felt throughout the long line of carriages; this is all the inconvenience which is found on stopping. There is no shaking, no bumping; the movement is as easy as that of a gentleman's carriage. This is very wonderful that from ten to twenty carriages press one against the other in the act of stopping; and but for the spring 'buffers' many of them would be broken and most of the passengers injured. There can be no doubt that in time so steady and smooth will be the motion of a railway train that coffee may be served up to the passengers without the risk of spilling.

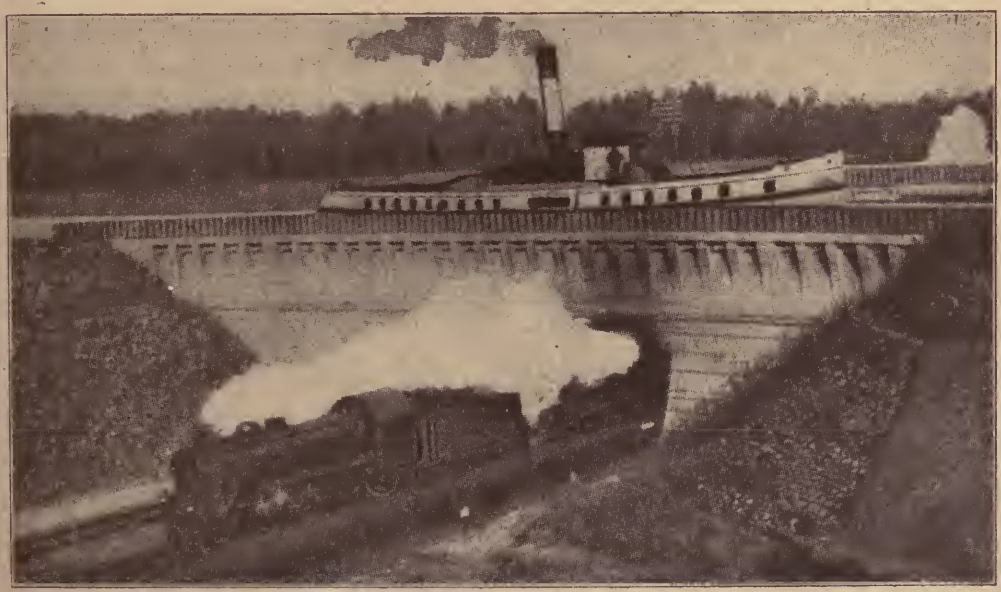
A TRAIN OF FIRST-CLASS CARRIAGES, LIVERPOOL AND MANCHESTER RAILWAY (1837).

"If you happen to see a train coming into a station, you have a very beautiful sight in the safe, quiet, orderly manner in which a hundred persons or more are brought at one time to one place. The carriages glide along so smoothly and quietly that they seem to be self-moving; and the order and regularity, the dignity and importance of the train, give the whole matter an air of national grandeur. Every train seems to be a royal procession; every passenger a person of distinction."

The success of these early railways resulted in the making of lines in all parts of the land; and among our illustrations you can see examples of the engines used to haul these early passenger and goods trains which, until their reliability and efficiency had been proved, people despised and feared.

Very quickly the queer-looking engines of the early days of the railway gave place to a stronger and swifter kind, like those with an eight-feet driving-wheel, such as "The Lord of the Isles," made by Sir D. Gooch; and the handsome engine that drew the train in which King Edward VII. and Queen Alexandra rode from London to Sandringham on their Wedding Day, March 10, 1863.

W. R. R.



[*E. N. A.*

A SHIP CANAL CARRIED OVER A RAILWAY, NEAR STETTIN, GERMANY.

STOP SIGNAL WITH DISTANT ARM BELOW, L.B. & S.C.R.

to and fro. By means of ropes and counterweights he found it possible to work the arms on both posts from a position halfway between them. His inspector caught him doing this, and reported him to a superior official, who at once realized the value of the invention. It showed that one man could work a lot of signals from a selected position, which now that traffic was so rapidly growing, and the need of more signals was felt, was an important consideration. So that is how the signal-cabin came to be invented.

However, we are forgetting that the signals alone cannot guarantee the safety of the train, or compel it to take the correct rails at a junction. The track itself, where it bristles with points, enabling a train to pass from one line to another, must first be prepared. To begin with, the two systems were worked more or less separately, the men who controlled the points being called pointsmen. But when signal cabins were set up, it was decided to put within them the levers that worked the points as well as those which worked the signals, and shortly afterwards means were devised to prevent the signal indications from disagreeing with the position of the points. For example, if the points were set for a branch line, the signalman could not move the lever controlling the signal of the main line; or if the main line signal was right for a train to pass, he was powerless to move the points that would turn the train into the branch. This is what is called "interlocking." For some time only one type of fixed signal was employed, namely, that which meant "stop." The increasing number and speed of trains led, however, to the introduction of the "distant" signal, that is, a signal placed in advance of the point of danger, its function being to repeat the indications of the stop signal, so that if the latter is at danger the driver has timely

notice of the fact, and can at once reduce the speed of his train.

The " distant " signal is distinguished by its notched or fish-tailed blade, and it is the only fixed signal which a train may run past when the arm is in the horizontal position. But how is a " distant " signal to be distinguished at night ? The answer is, by the driver's knowledge of the road. Nevertheless, some attempt has been made to give this signal a different light from red when it signifies caution. On the Underground Railways the distant signals show a yellow light, which changes to green when the arm is turned down, and the side of the arm which confronts a train is likewise painted yellow. On some railways, too, a lamp is used which shows a white >. alongside the red or green light.

As soon as the electric telegraph was invented its value as a means of controlling the passage of trains was realized. Seventy years ago the Great Western Railway began to telegraph the arrival and departure of its trains from station to station for a distance of about 20 miles out of London. If a second train should arrive at any telegraph station before the previous train was telegraphed from the next station as " arrived," it was stopped by signal, and detained until such message was received.

This was to all intents and purposes the block system, although the latter was not generally adopted until many years later. All our railways are now compelled by law to work their lines on the block system and to interlock their points and signals.

The block system maintains a certain interval of space between trains instead of the uncertain interval of time formerly observed. The line is divided into sections, varying in length according to the

GIRDER SIGNALS WITH LETTERS INDICATING SECTIONS, L.B. & S.C.R

SOUTH SIGNAL GANTRY, CREWE, LONDON & NORTH WESTERN RAILWAY.

to the arm. In the neighbourhood of terminal stations, where all trains have to travel slowly, letters denoting the tracks to which the signals refer may be painted on the surface,—for example, "M.L." meaning main line, "L. to M." loop line to main line, etc. Again, there may be section indicators underneath the signals, which display numbers, and so tell the driver of an incoming train which section or platform he will arrive at—1, 2, or 3, etc.

When the first railways were opened, the only arrangements for signalling trains were white, green, and red flags by day, and lanterns showing these different colours by night.

"White is right, red is wrong,
Green is gently go along."

The flags and lanterns were shown by men called railway policemen, who were dressed just like the first policemen, in top hats and white trousers, and stationed at intervals along the line. But the policemen could tell the driver nothing until the train was close to him, neither was he in communication with the other policemen on either side of him. All that he could do was to notify the safety or otherwise of the line as far as he himself could see it. If a train broke down when hidden from sight by a curve or tunnel a short distance away, he would have no knowledge of the fact.

The next step was to substitute fixed signals for the hand-waved flags and lamps, so that the driver could catch sight of them a greater distance away.

A DISTANT SIGNAL, L.B. & S.C.R.
May be passed with caution.

ADVANCE SIGNAL, L.B. & S.C.R.

The earliest fixed signals were canvas discs, squares, or hoops, on the top of poles. At last a much better type of signal was adopted, viz., the semaphore pattern, which is the railway signal of to-day. The latter, when first introduced, had three positions, viz., turned out horizontally it meant "danger," "stop"; turned diagonally or half-lowered it meant "caution," "go slowly"; and completely dropped, disappearing within the post, "line right for the approach of train." At night, of course, these different positions each required a different light, red, green, and white respectively, which was secured by the movements of the arm causing coloured glasses, termed "spectacles," to revolve in front of a lamp. After a train had passed, a signal was kept for three minutes in the "danger" position, then for seven minutes more in the "caution," and when ten minutes had elapsed it was dropped to "line clear." This system was called "time signalling," for it ensured an interval of time between trains following one another on the same line. A policeman, or, as he soon came to be called, a signalman, was stationed at the foot of the post to work the arms. Now at this time there was a lazy signalman who had charge of two posts some little distance apart. He was struck by a brilliant idea to save himself the walk

SIGNAL GANTRY AT RUGBY, LONDON & NORTH WESTERN RAILWAY.

STOP SIGNAL WITH DISTANT ARM BELOW, L.B. & S.C.R.

to and fro. By means of ropes and counterweights he found it possible to work the arms on both posts from a position halfway between them. His inspector caught him doing this, and reported him to a superior official, who at once realized the value of the invention. It showed that one man could work a lot of signals from a selected position, which now that traffic was so rapidly growing, and the need of more signals was felt, was an important consideration. So that is how the signal-cabin came to be invented.

However, we are forgetting that the signals alone cannot guarantee the safety of the train, or compel it to take the correct rails at a junction. The track itself, where it bristles with points, enabling a train to pass from one line to another, must first be prepared. To begin with, the two systems were worked more or less separately, the men who controlled the points being called pointsmen. But when signal cabins were set up, it was decided to put within them the levers that worked the points as well as those which worked the signals, and shortly afterwards means were devised to prevent the signal indications from disagreeing with the position of the points. For example, if the points were set for a branch line, the signalman could not move the lever controlling the signal of the main line; or if the main line signal was right for a train to pass, he was powerless to move the points that would turn the train into the branch. This is what is called "interlocking." For some time only one type of fixed signal was employed, namely, that which meant "stop." The increasing number and speed of trains led, however, to the introduction of the "distant" signal, that is, a signal placed in advance of the point of danger, its function being to repeat the indications of the stop signal, so that if the latter is at danger the driver has timely

notice of the fact, and can at once reduce the speed of his train.

The " distant " signal is distinguished by its notched or fish-tailed blade, and it is the only fixed signal which a train may run past when the arm is in the horizontal position. But how is a " distant " signal to be distinguished at night ? The answer is, by the driver's knowledge of the road. Nevertheless, some attempt has been made to give this signal a different light from red when it signifies caution. On the Underground Railways the distant signals show a yellow light, which changes to green when the arm is turned down, and the side of the arm which confronts a train is likewise painted yellow. On some railways, too, a lamp is used which shows a white >. alongside the red or green light.

As soon as the electric telegraph was invented its value as a means of controlling the passage of trains was realized. Seventy years ago the Great Western Railway began to telegraph the arrival and departure of its trains from station to station for a distance of about 20 miles out of London. If a second train should arrive at any telegraph station before the previous train was telegraphed from the next station as " arrived," it was stopped by signal, and detained until such message was received.

This was to all intents and purposes the block system, although the latter was not generally adopted until many years later. All our railways are now compelled by law to work their lines on the block system and to interlock their points and signals.

The block system maintains a certain interval of space between trains instead of the uncertain interval of time formerly observed. The line is divided into sections, varying in length according to the

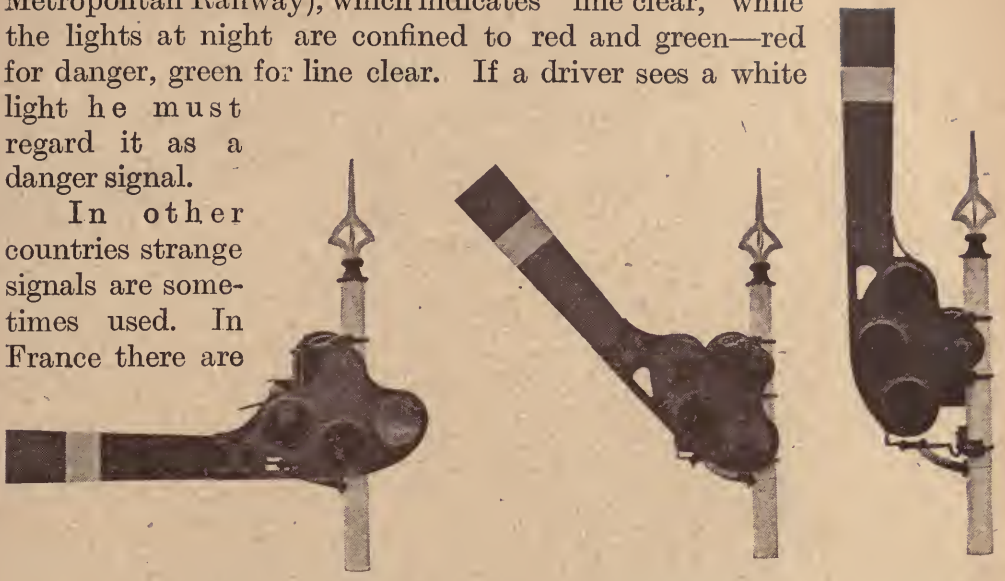
GIRDER SIGNALS WITH LETTERS INDICATING SECTIONS, L.B. & S.C.R

amount of traffic that has to pass over them, and a signal box is placed where one section ends and another begins. A railway worked on this system may be compared to the staircase of a house. The landings are the signal boxes, and the separate flights of steps between each landing the blocks or sections. No train may leave the bottom of the stairs until both the first flight and the first landing are clear, and so on throughout the length of the railway; hence, two trains travelling on the same line should never be in the same section at the same time, provided that the signalman does his duty. The introduction of the block system carried with it the keeping of all signals at danger, except when the signalman had asked and received permission over the telegraph from the signal box in advance to lower his signals for a train to pass; and as soon as a train had passed his own box he put his signals back to danger. Consequently, the old intermediate time signal to denote caution was abolished. Semaphore signals now have only two positions—the horizontal, which means "danger," and the downwards (*upwards* on part of the

ELECTRIC LAMP SIGNALS, WITH SHADES FOR DAY USE, AT BAKER STREET STATION, METROPOLITAN RAILWAY.

Metropolitan Railway), which indicates "line clear," while the lights at night are confined to red and green—red for danger, green for line clear. If a driver sees a white light he must regard it as a danger signal.

In other countries strange signals are sometimes used. In France there are



Stop. Go Carefully. Go Ahead.

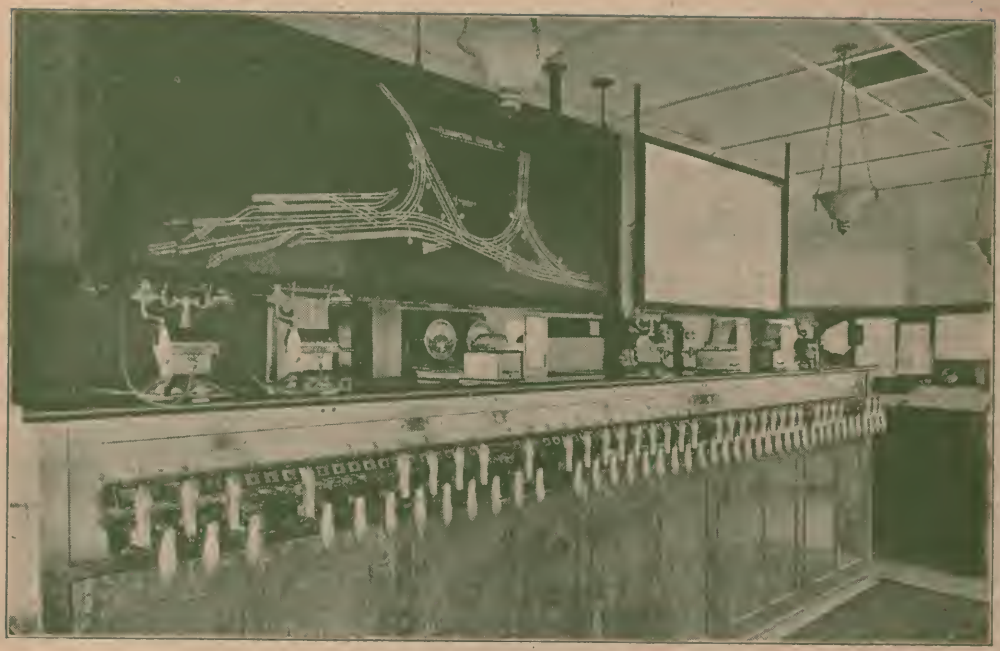
AUTOMATIC "THREE-POSITION" SIGNALS.

queer chessboard signals consisting of boards showing four red and white or green and white squares. These boards are turned edgeways when the signal is clear, so that if a driver sees the board showing towards him he knows he must pay attention.

In America railway engineers go in for what are termed "three-position" signals, and a few have recently been erected in Great Britain. By this means one signal arm serves the purpose of two. In the horizontal position it means *stop*, as usual, and the light is red. Turned upwards at an angle, with a yellow light, one section ahead is clear; that is, the driver must go carefully, prepared to stop at the next signal. Turned up vertically, pointing to the sky, with a green light, is equivalent to the distant signal being off, and signifies "go ahead."

THE MECHANISM WHICH OPERATES THE ARM.

In tunnels disc and lamp signals without arms and depending only upon the colour of the light shown are often used. On some of the electric railways lamp signals are even used in the open spaces, by fitting shades in front of the lights so that the colours show up very nearly as well as in the darkness.



ELECTRIC SIGNALLING.

A busy power frame on an Australian railway, with illuminated diagram by which movements of trains can be observed.

Signals and Signalling—II

THE adoption of the block system increased the number of stop signals, which now comprise the following:—the "home," which is placed at the entrance of a section; the "starting," which is situated at the departure end of a station; the "advanced-starting," which enables a train to pass the "starting" merely in order to shunt or to clear the station, without really entering the section in advance. In addition, there are "calling-on" and "backing" arms, which are smaller, and, as their names imply, call on a train to enter a siding, or tell it to move backwards, together with a few other special signals. Lastly, the points of all sidings and most cross-overs are furnished with little signals on the ground—discs or dwarfed arms; but the points at the junction of two through roads always have full-sized semaphore signals in order to notify a driver very clearly which route his train has to take. Very often we see miniature signals at or near the foot of a signal-post. These are for the guidance of the fog signalmen. When a fog or snowstorm prevents the enginemen from seeing clearly,

the signal indications are conveyed to them by sounds—the explosion of detonators placed on the rails, where the wheels of the engine crush and fire them. So long as a signal is at "danger" the fogman keeps two detonators fastened to the rails (two being used in case one should fail), and when the driver hears the bang! bang! he shuts off steam, and pulls cautiously up to the place where the fogman is standing. The fogman then tells the driver by word of mouth or by lamp or flag when the signal arm has turned to safety. But the fogman himself may not be able to see the arms at the top of lofty posts, so these miniature signals, which repeat the movements of the larger semaphores, are provided near the ground. On many railways an apparatus is used which enables a signalman himself to place fog-signals on the metals without leaving his cabin. It is a kind of mechanical arm, and attached to it is a magazine of detonators. This apparatus is very valuable when a fog comes on suddenly and there is no time to summon the men who are enrolled as "foggers."

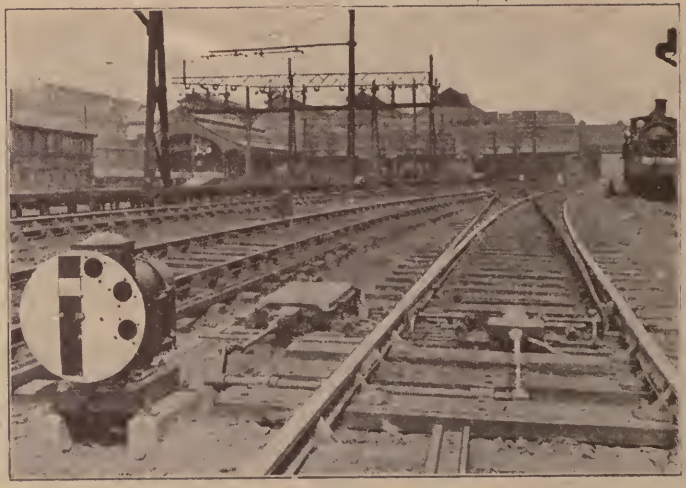
WARNING SIGNALS (ON GROUND).

AN ELECTRIC SIGNAL AT THE SIDE OF THE ORDINARY POST, L.B. & S.C.R.

Let us now have a look round the interior of a signal-box. A shelf runs above the row of levers, and on it stand a number of electrical instruments, all of which have dials something like clocks, while many have little handles or buttons beneath, and bells or gongs on the top of the case. By means of these instruments

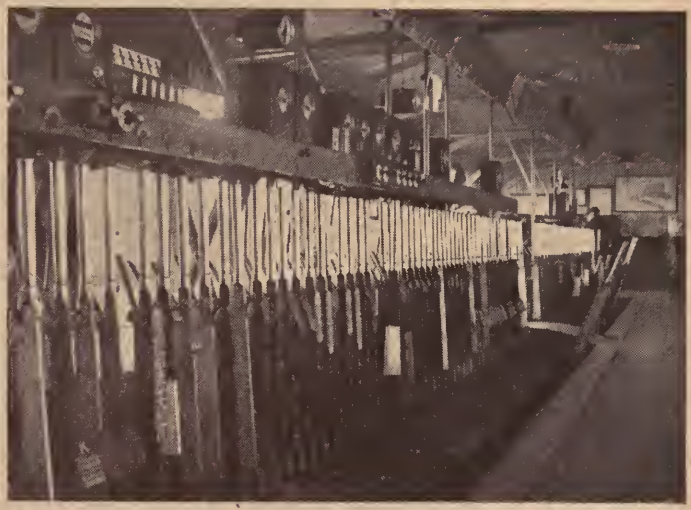
SHUNT SIGNAL, 45° POSITION (GO CAREFULLY), SOUTH EASTERN & CHATHAM RAILWAY.

the signalman communicates with the signal-boxes on either side of him. He tells the signalman in advance when he expects a train, and inquires of him if his section is clear, so that he may pass the train on to him. If the signal-box in advance "accepts" the train, our man lowers his signals, and then sends the signal "Train on Line" as soon as the train has passed. He also tells the signalman in the box behind that the train has cleared the section in the rear. In due course, a signal comes back that the train has safely arrived at the next box. All these different signals are made to both the ear and the eye by turning the keys or pressing the buttons of the block electric instruments. The audible signal consists of bell beats, and the bells have different tones, one for the "up" line, another for the "down." Moreover, when the first signalman works the bell, the number of beats which he gives tells the next man what to expect—whether an express passenger, slow, goods or branch line train or a light engine, etc. The signal for the eyes appears on the dial of the instrument. It may be that a needle points to

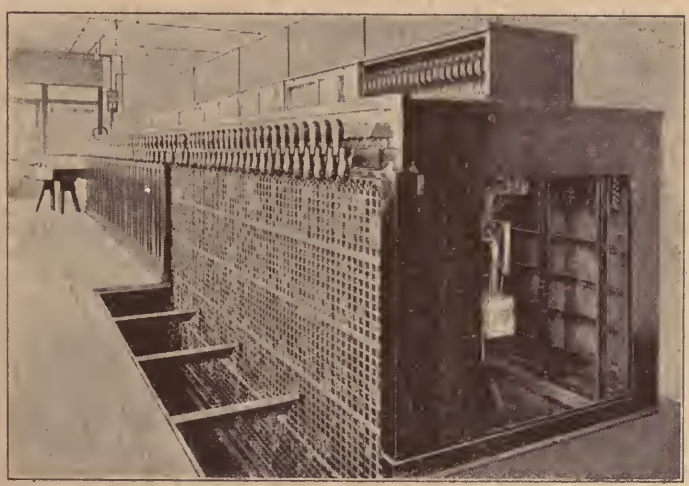


SHUNT SIGNAL, 90° POSITION (GO AHEAD).

"Line clear," "Train on line," "Train out of section," etc., or that different coloured shutters inscribed with these words appear through an aperture in the dial. When the instruments are not in use the handles must always be kept so that the needles or shutters point to nothing; and signalmen on setting the needle to "Train on line," or "Line clear," must take care that it is firmly and completely pegged over. Ordinary telegraphic instruments, together with telephones, are provided so that one box may talk to another. The shelf also contains a number of repeating instruments, which tell the signalman whether the signals really have moved in obedience to the levers, and whether the signal lamps are burning properly. The former type of repeater is usually in the form of a miniature semaphore. The lamp repeater acts as follows :



A SIGNAL BOX FRAME, VAUXHALL, LONDON & SOUTH WESTERN RAILWAY.

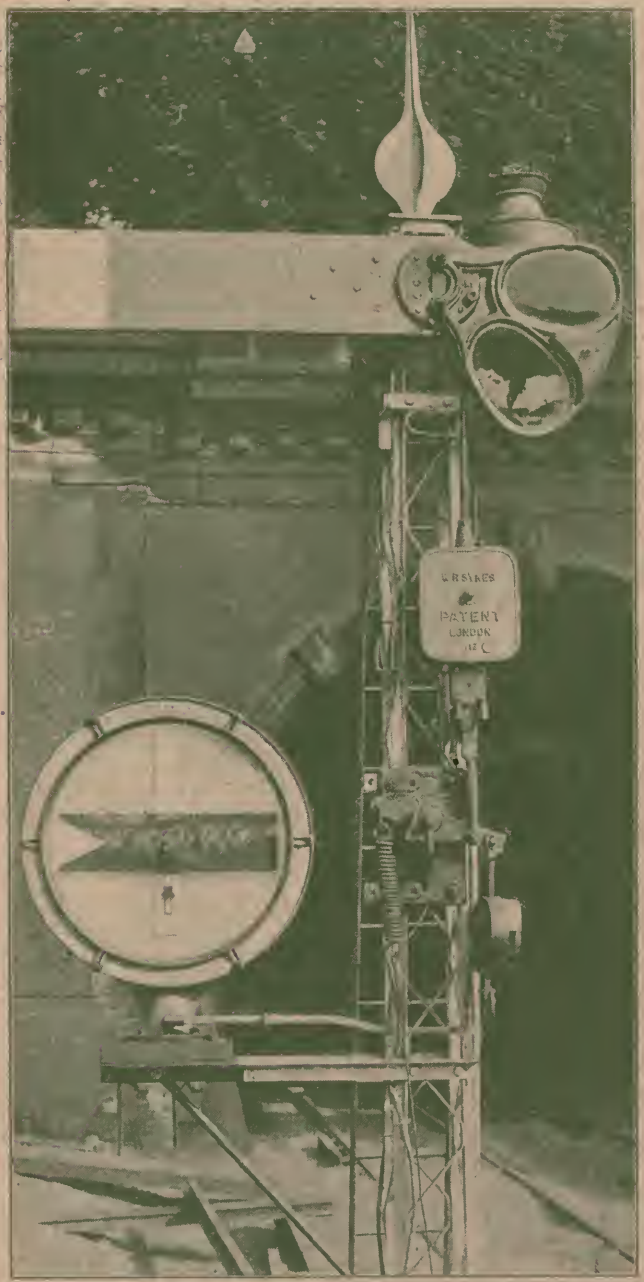


INSIDE A POWER SIGNAL CABIN, SHOWING LOCKING MACHINE, SOUTH EASTERN & CHATHAM RAILWAY.

Over the flame of the lamp is a tongue consisting of two strips of different metals, and this remains bent so long as it is hot. If the light goes out the tongue cools and straightens itself, thereby touching another piece of metal and completing an electric circuit, which sets a

bell ringing in the repeater, and at the same time changes a shutter, with the words "light in," to another which says "light out."

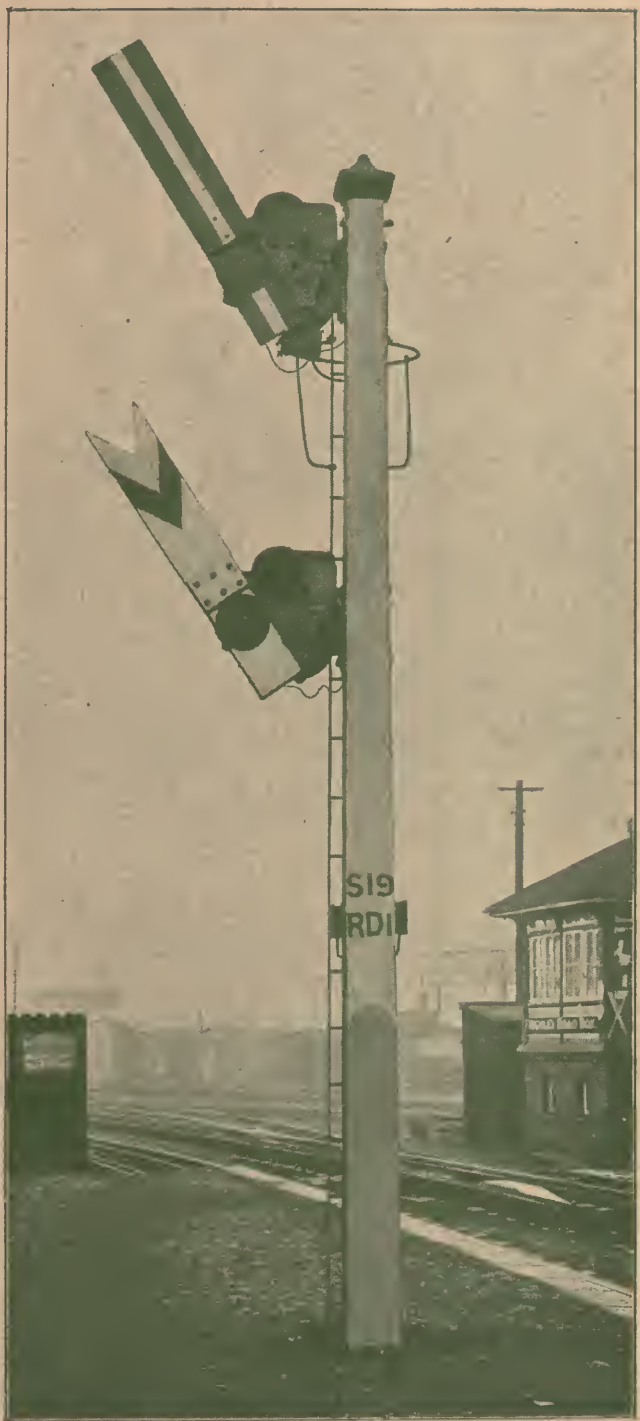
Next let us look at the lever frame. Every lever bears a number, and on the floor beside it, or on a board in front, is a plate which describes its duty, thus "down distant," "up home," "Slocum junction facing points," etc. Then the levers are arranged in groups, each group being painted a different colour. Thus, all the home signal levers are in a cluster, and painted red, while the distant signal levers are coloured green, the point levers black, and spare levers white. In junction signal-boxes it will be seen that many levers bear an array of numbers. These numbers form the key to the interlocking. Before such a lever can be moved, each of the other levers to which the numbers on it refer must first be moved in due order. The interlocking frame is underneath the floor of the cabin. The whole may be com-



SYKES' "BANNER" TYPE ELECTRIC DISTANT SIGNAL AT ENTRANCE TO SYDENHAM HILL TUNNEL.

pared to a piano or organ—the levers being the keyboard, and the interlocking frame the works. But whereas the piano-player can produce, if he wills it, the most dreadful discord, not so the signalman, for the interlocking frame compels him to play in tune, that is to say, he is powerless to make contradictory movements of levers.

Yet another refinement is known by the name of the "lock and block" system. This prevents any two signalmen in adjacent boxes from misunderstanding one another. The electrical instruments in the two boxes are not only joined by electric circuits, but they are also electrically connected with the levers, so that certain of the levers are locked unless the instruments show that they can be safely moved. Thus, no signalman has complete control of the mechanism in his own box,



UPPER QUADRANT HOME AND DISTANT ELECTRIC SIGNALS, METROPOLITAN RAILWAY.

NEW TYPE SHUNT SIGNAL, ON BRACKET, IN COMPARISON WITH OLD TYPE JUST IN FRONT.

for unless the neighbouring signalmen have operated their instruments as required he cannot pull over any of the signal or point levers. Therefore, if one signalman gets flurried he finds that he is physically controlled and prevented from making a mistake by the signal-box on either side.

However, locking does not begin and end with the frame in the signal cabin. The rails themselves, and especially the points, are equipped with a number of clever contrivances to ensure the safe passage of the trains. Suppose that a point rod has broken, and the points have not moved when the signalman pulled the lever. An apparatus called the "detector lock" will then prevent the lowering of a signal which would be contrary to the actual position of the points. Then the facing point lock ensures that the points are set close to the stock or fixed rail, for were they not the train might be derailed. When a train is passing over points, the latter cannot be altered by the signalman, for the wheels are pressing down a long flat bar of iron called the locking bar, which must be raised above rail level every time the points are to be moved.

Until comparatively recently, all signals and points were operated by the strength of the signalman; and it requires a long, hard pull to move the lever that works the signal or pair of points some distance away. Many of the larger signal-boxes now contain what are known as power installations. The levers are quite small, and a child could move them to and fro. The release of a lever causes a current of electricity, or a puff of compressed air, to fly away to an electric, air, or gas motor belonging to each signal or pair of points, which motor instantly performs the operation of moving the signal arm or the points

as required. All this, of course, does away with direct mechanical connections in the shape of signal wires and point rods, which are always liable to get out of order from variations of the temperature and from becoming clogged with snow or dirt. Moreover, the presence of wires and rods a few inches above the ground is a source of danger to men working on the line. Many a poor shunter and platelayer has tripped over these obstacles, and been run down by a train in consequence. The pipes which transmit the compressed air or contain the electric wires for power signalling are laid underground, where they neither can suffer nor do harm.

A different kind of signal from the semaphore pattern is used with some power plants. It consists of a strip of red cloth in a circular case with a glass front, and this strip can be inclined from the horizontal in the same way as a semaphore arm. The case is transparent, so that the light from a lamp can shine through it at night;

ELECTRIC MECHANICAL SIGNAL CABIN AT VICTORIA, L.B. & S.C.R.
The signals are worked electrically by the small hand levers.

SIGNALLING SCHOOL, LANCASHIRE AND YORKSHIRE RAILWAY.

therefore, the "banner" signal, as it is called, takes the same form by night as by day.

It should be explained that power signalling permits of signals and points being worked at a greater distance from a signal-box than would be possible with the old manual system.

A new and very wonderful development of railway signalling is the automatic installation, in the sense that between signal cabins on stretches of line where there are no junctions or cross-over roads requiring the movement of points (which in turn make necessary the services of signalmen) the movement of the signal arm protecting a section is determined by the passage of the train itself. Calling two successive automatic signal sections A and B, the train, as it passes from section A to section B, must automatically put the signal at the entrance to B to "danger," and, at the same time, must pull off the signal at the entrance to A. These operations require the normal position of the signal arm to be "off" instead of at "danger," as in the usual practice. Each signal arm is operated by an electric, gas, or air motor, and the agency by means of which the train acts as its own signalman is electricity contained in the running rails. The

OPERATING A 2-INCH GAUGE ELECTRIC RAILWAY.

wheels of the train bring the track battery, as it is called, into play, and the latter puts the actual motive power of the signal arms into operation. Exactly the same signal movements as are caused by the passage of a train would be produced were we to connect the two rails of the track by a piece of wire or metal bar. Automatic signalling conveys direct messages to the driver. If a signal is at "danger" he knows that there is a train in the section, if "off" it is a guarantee that the section is clear. Another advantage of automatic signalling is that it permits a maximum number of trains to be passed over a given stretch of track. The most important and ingenious installation of this kind is that installed on the Metropolitan District and allied Tube railways, on some sections of which and during certain periods of the day a train is run nearly every minute on each line. H. G. A.

SOME FRENCH RAILWAY SIGNALS.

The fish-tailed semaphore on the left, when pointing downwards, indicates that a train is to take the junction.

The semaphore signal, when at "all clear," hangs downwards in a line with the signal post. This design is usually employed at the entrance to block sections.

The lower of the two "chessboards" is coloured red and white, and in the position shown indicates danger. If the line is clear the face of the signal is turned parallel with the track.

Green and white chessboards are used as "distant" signals. The diamond-shape mounting of the upper board indicates that less than the normal distance separates that post from the next stop signal.

Signals for Signalmen

AS has already been explained, before a train can be allowed to pass, a series of telegraphic messages have to be exchanged between the signalmen. When one signalman wants to send a train he must first ask the next man whether he can do so. Electrical instruments are used for this purpose, but most of the messages are sent by bell signals. First, a signalman rings once to call attention.

This is repeated back to show that the second signalman is taking notice. Then so many rings, with perhaps one or two pauses, are given, thus sending the message itself, and this is repeated back to show that it is understood. Most of the railways now use the same code of bell signals, which is as follows:—

	Beats on Bell.	How to be given.
Call attention	1	1
Is line clear for express passenger train or breakdown van train going to clear the line, or light engine going to assist disabled train?	4	4 consecutively
Is line clear for ordinary passenger train or breakdown van train not going to clear the line?	4	3, pause, 1
Is line clear for branch passenger train?	4	1, pause, 3
Is line clear for fish, meat, fruit, horse, cattle, or perishable train composed of coaching stock?	5	5 consecutively
Is line clear for empty coaching stock train?	5	2, pause, 2, pause, 1
Is line clear for fish, meat, or fruit train composed of goods stock, express cattle or express goods, Class "A"?	5	3, pause, 2
Is line clear for express cattle or express goods, Class "B"?	5	1, pause, 4
Is line clear for light engine or light engines coupled together, or engine and brake?	5	2, pause, 3
Is line clear for through goods, mineral or ballast train?	5	4, pause, 1
Is line clear for ordinary goods or mineral train stopping at intermediate stations?	3	3 consecutively
Is line clear for branch goods train?	3	1, pause, 2
Is line clear for ballast train requiring to stop in section?	5	1, pause, 2, pause, 2
Is line clear for platelayers' lorry to pass through tunnel?	5	2, pause, 1, pause, 2
Train entering section	2	2 consecutively
Bank engine in rear of train	4	2, pause, 2
Train out of section, or obstruction removed	3	2, pause, 1
Obstruction danger	6	6 consecutively
Blocking back	6	*Inside* home signal 2, pause, 4 *Outside* home signal 3, pause, 3
Stop and examine train	7	7 consecutively
Cancelling "Is line clear?" or "Train entering section" signal	8	3, pause, 5
Train passed without tail lamp	9	9 consecutively to Box IN ADVANCE 4, pause, 5 to Box IN REAR
Train divided	10	5, pause, 5
Shunt train for following train to pass	11	1, pause, 5, pause, 5
Vehicles running away on wrong line	12	2, pause, 5, pause, 5
Section clear, but station or junction blocked	13	3, pause, 5, pause, 5
Vehicles running away on right line	14	4, pause, 5, pause, 5
Opening of signal box	15	5, pause, 5, pause, 5
Testing of bells	16	16 consecutively
Closing of signal box	17	7, pause, 5, pause, 5
Time signal	18	8, pause, 5, pause, 5
Lampman or fog-signalman required	19	9, pause, 5, pause, 5

ONE OF THE WORLD'S BIGGEST LOCOMOTIVES.

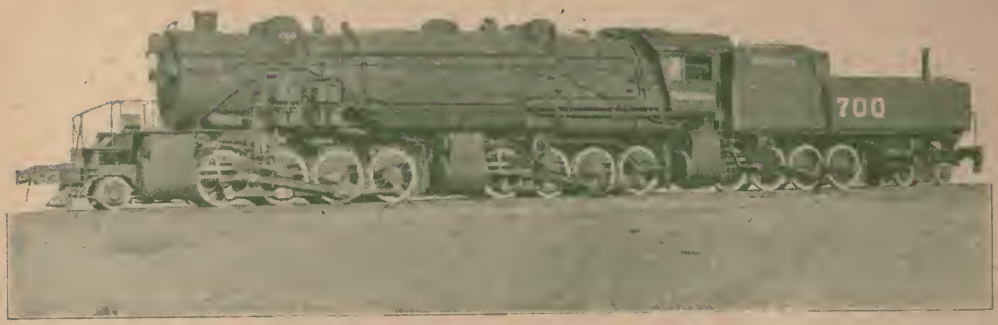
This monster, which is used for heavy freight trains on the Erie Railroad, is known as a "Triple Articulated (jointed) Compound Locomotive." It has a pair of leading wheels, twelve pairs of driving wheels, and a pair of trailing wheels—twenty-eight in all. Including tender, the weight is over 380 tons, as against the 143 tons of the "Great Bear," the biggest engine in Great Britain.

Monsters of the Rail

AMERICA is sometimes called the "land of big things," and it is certainly true that we must go to the United States to find all the biggest railway locomotives and cars. This is partly due to the fact that, until the last twenty or thirty years, very few bridges were built over American railways, long tunnels are not numerous, and station platforms, if provided at all, are very low, so that when railway engineers began to find it necessary to build big locomotives they could make them almost as high and as wide as they wished.

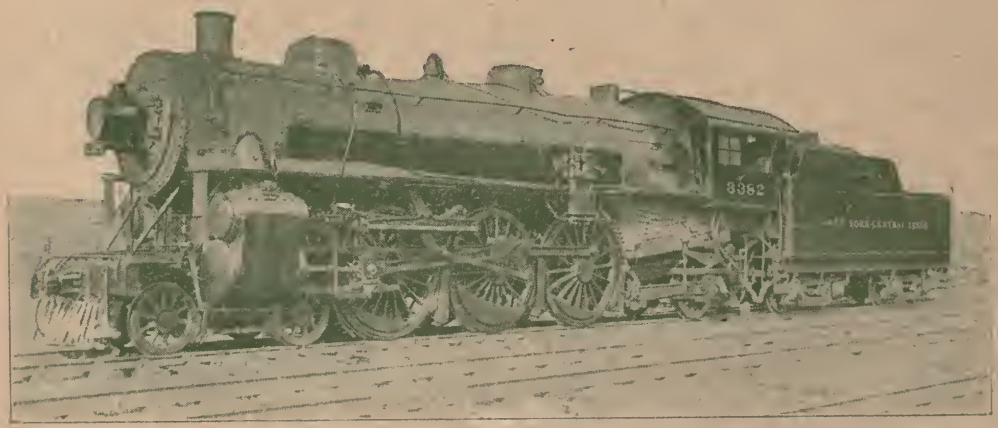
When American railways began to make up their trains to great weight, they could build engines big enough to pull them, and then they could add to the weight of the train and make engines bigger again, and so on, until we find there many locomotives alongside which even the largest British engines look quite small. While there are, of course, many smaller engines still at work, practically every express train is pulled by a big 4–6–2 engine weighing at least 150 tons without its tender (the "Great Bear," Great Western Railway, weighs 97 tons, or 143 tons with its tender), while the mountain and freight engines are larger still.

SOME HUGE AMERICAN LOCOMOTIVES



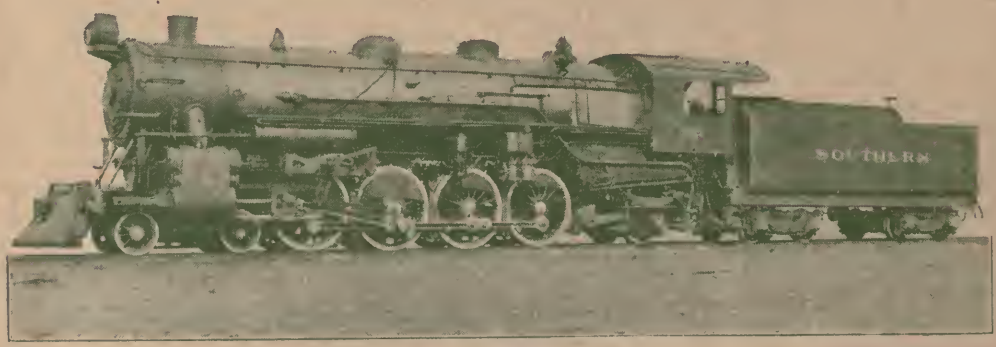
2–8–8–8–4 TYPE, VIRGINIAN RAILWAY.

This triple articulated compound locomotive is nearly 100 feet in length, and has a total weight of 376¾ tons and a tractive force of 166,300 lb. It is used for heavy coal traffic on gradients of about 1 in 50.



4–6–2 TYPE, NEW YORK CENTRAL AND HUDSON RIVER RAILWAY.

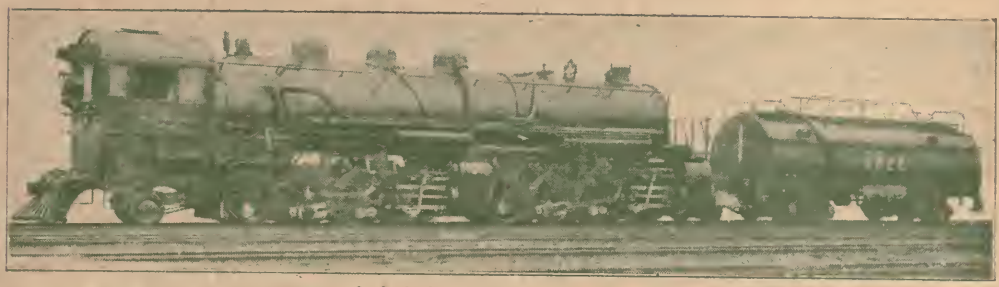
Used for the "Empire State" and other expresses between New York and Chicago. These engines will pull ten or twelve 70-ton steel coaches at express speed.



4–8–2 TYPE, SOUTHERN RAILWAY.

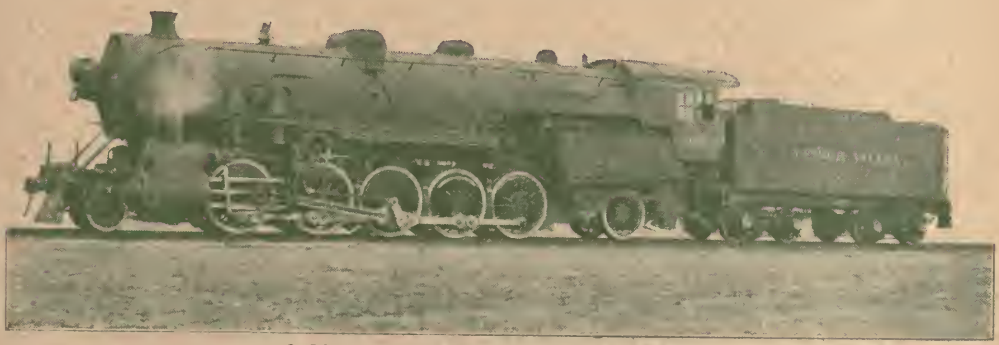
Has a total weight of about 215 tons. Used for passenger service.

SOME HUGE AMERICAN LOCOMOTIVES



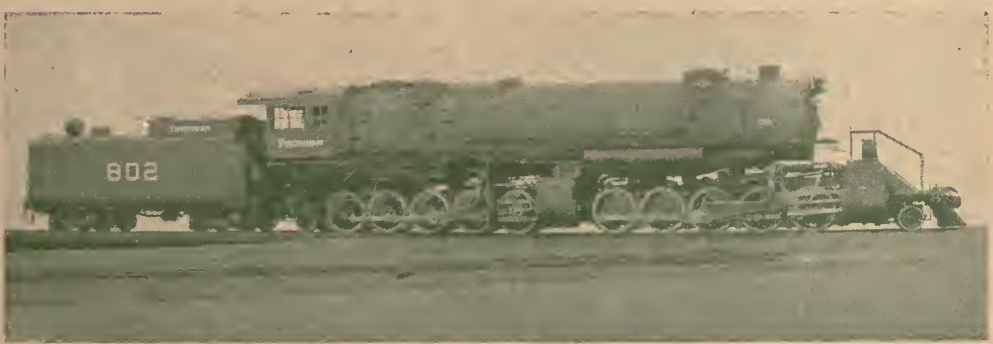
A REVERSED OIL-BURNING 2–8–8–2 ENGINE ON THE SOUTHERN PACIFIC RAILWAY.

The driver's cab is placed in front, and the oil tender is towed at the funnel end of the locomotive.



2–10–2 TYPE, LEHIGH VALLEY RAILROAD.

Has a total weight of over 240 tons. Used for freight service. These engines will pull fifty or sixty loaded bogie freight cars, each carrying 30, 40 or 50 tons of coal, wheat, etc., and there may be 1,500 or 2,000 tons behind the tender.



2–10–10–2 TYPE, VIRGINIAN RAILWAY.

In order to get a full-weight freight train over a mountain section without dividing it, one of these powerful engines pushes behind until the gradients become easy enough for the engine in front to manage by itself.

The 4–6–2 " Pacific " illustrated is one of the big engines on the New York Central Railroad, used for the " Empire State Express " and the " 20th Century Limited Express " between New York and Chicago. But some passenger engines are even larger, and this type is now used on nearly every main route.

In places express trains have to be taken through the mountains, and here 4–8–2 engines of what is known as the " Mountain " type, or else goods engines of the " Mikado " (2–8–2) type are used.

But it is for freight traffic that the real " monsters " of the rail are used, and most of these are " Mallet " compounds, with two sets of coupled wheels and cylinders, the front set being fitted in a movable frame so that, although the engine is so long and huge, it can pass round fairly sharp curves. These engines often weigh over 200 tons without tender, and with two sets of 8 wheels coupled, give no fewer than 16 wheels to take part in pulling. Some of these engines are used on ordinary lines for trains of 2,000 tons or more, but they are chiefly employed on the steep sections.

In America big loads have often to be pulled a thousand miles or more on one journey, and when there is a steep section in the middle it is too much for an ordinary engine to take the whole load in one operation. But if the train is divided and taken over in two parts delay is caused before they can be joined again, so the usual method is to provide one of these very big engines as a " pusher." The ordinary engine remains in front, but a big Mallet is brought up behind, and between them they get the whole train, without dividing it, over the steep section.

These 2–8–8–2 Mallets are now quite numerous and some of them are enormous engines even for America. But there are a few locomotives even more remarkable. These are known as " Triplex " engines. They have two sets of 8-coupled wheels under the boiler and a third set under the tender, so that there are no fewer than 24 driving wheels, and the whole machine weighs 350 tons, or even more.

With boilers so enormous it would be almost impossible for a fireman to keep the furnace going, so some of the engines burn oil, and in that case can be so arranged that the driver's cab is in front with the tender attached behind at the chimney end, as in the case of the Southern Pacific engine illustrated. Most engines have also apparatus for feeding coal from the tender to the fireman, and sometimes there is an automatic stoker to supply the coal right into the firebox.

A TRAIN OF SECOND- AND THIRD-CLASS CARRIAGES, LIVERPOOL & MANCHESTER RAILWAY (1837).

Early Days

LONG before the days of the locomotive, tramways were in use, mostly in connection with collieries, to carry coal from the pit-mouth to a neighbouring canal; and there can be little doubt that a tramway, made in 1776, with cast-iron rails, at a Sheffield colliery, was the object from which engineers learned to lay down metals for the trains.

Years before the making of the first steam railway, a few locomotives had been built to run along the ordinary roads, and some of them, together with a few steam carriages, continued in use even after the coming of the railway locomotive. They were not received with much favour; but that the idea is still being carried out all of you know who have seen a traction-engine.

When people had fully realized how easily and evenly, and how much more quickly, trains ran along the metals, a demand arose in course of time for rails to be laid in the streets; and in 1861 an American, named G. F. Train, laid down a tramway in London from the Marble Arch to Shepherd's Bush for carriages drawn by horses. They were the first trams to run in London. They were not popular, however, and were withdrawn in the following year. Soon afterwards an attempt was made to introduce steam trams; but it was not successful, for when the engines made a noise it was said they would frighten the horses; and if they came along quietly, it was thought that people would get run over. The quaint picture on p. 95 shows the highly ornamented steam road carriage which ran in 1835 between London and Birmingham. It held 50 people, 28 inside and 22 outside.

In time, horse-driven trams ran to the outlying parts of London

A LIVE-STOCK TRAIN IN 1837.

in nearly every direction along metals; and those who objected to steam trams along the streets of our towns never imagined for a moment that the day would come when electric cars would replace almost everywhere the horse trams.

You can see on other pages pictures of the early railway carriages, the third-class like an open cattle truck, with wooden boards across for seats; the second-class with an awning at the top beneath which in cold weather the wind would whistle in the ears of the shivering passengers; and the first-class which, although covered in, was not nearly so comfortable a carriage as even the worst third-class of to-day.

As years passed, and the engines became more perfect and speedy, so were the carriages improved; and about thirty years after George Stephenson's train first ran along the metals, the carriages were made of a somewhat similar pattern to those of to-day. But though so superior to the old ones they were very clumsy in comparison with the

THE PROGRESS OF STEAM.

When steam vehicles were introduced there was a great outcry against them. An artist of that period (1831) thus recorded his idea of a scene in Regent's Park.

AN EARLY STEAM CARRIAGE, CONSTRUCTED BY GOLDSWORTHY GURNEY, A FAMOUS EARLY NINETEENTH-CENTURY INVENTOR.

A quaint notice issued at the time drew attention to the fact that "the chimneys are fixed on the top of the hind boot, and as coke is used for the fuel there will be no smoke, while any hot or rarified air produced will be dispelled by the action of the vehicle. The rate of travelling is intended to be from 8 to 10 miles per hour." The carriage carried six inside and twelve outside passengers.

beautiful and comfortable carriages in which we ride in modern times. Very interesting is a first-class carriage, built in 1852, which ran for many years between London and Ipswich. In shape it resembles one of the old stage coaches, and under the seats are eight cast-iron blocks, each weighing 4½ cwt., placed to help the train to run steadily. It is the oldest carriage in the possession of the Great Eastern Railway and is preserved as a curiosity in the Company's works at Stratford, near London.

About 1850 was built a carriage with two second-class compartments and one first-class. The latter was comfortably fitted with green plush cushions and arm and head rests; but the second-class compartments had little more than half the space of the first, and contained nothing in the way of cushions to soften the hard surface of their plain wooden seats. On top of the carriage were racks for the luggage and the seat and foot rest for the guard, who in the early days of the railway had an outside place, just as in the old coaches.

Very curious pictures are to be seen of stations in early railway

times. In some places the station was nothing but a draughty barn, or a little shed, near to which the passengers, with their luggage close by, would wait patiently in a field or on a grassy bank for the train; but the most strange-looking of all seems to have been the hollow of a big tree which did duty as the railway station at Moreton, near Hereford, for some time after the opening in 1853 of the Shrewsbury and Hereford Railway, now part of the Great Western Railway.

What changes are brought about by the coming of the railway may be seen at Paddington, the headquarters of the Great Western Railway in London. A century ago Paddington was a quiet country village just off the Edgware Road, about a mile from London, and through it the stage coach rattled once a day with the guard playing the fiddle to amuse the passengers. Then came the railway, and with it the Passenger Station, followed by the Goods Station. Houses were built around the village, and soon little Paddington became a part, and a very important part, of mighty London.

[From a print lent by the Great Western Railway.

A VERY EARLY RAILWAY STATION.

This old tree at Moreton, near Hereford, was used as a station for some time after the opening of the Shrewsbury and Hereford Railway, now part of the Great Western system.

WILLIAM CHURCH'S STEAM ROAD CARRIAGE RUNNING BETWEEN LONDON AND BIRMINGHAM, 1835.

The first railway tickets were thin strips of paper, but as these were easily lost, the slip of cardboard, with which we are all familiar, came to be used instead. But on some railways the tickets were bronze discs about the size of half-a-crown.

Many laughable stories are told about ticket-collecting. Here is one. A young lady, when the collector asked for her ticket, searched her pocket and her satchel in vain. The collector, impatient at being delayed, asked rather crossly where she had put the ticket. "I think I put it in my purse," was the reply. She searched for her purse without success, and at last sorrowfully said, "It's in my box." "Where's your box?" inquired the collector; and the collector had to go away in despair when he heard the reply, "It's in the luggage van."

W. R. R.

The Christmas Porter

WHEN children go home for the Christmas vacation,
They're merry as merry can be,
As they crowd in the train at each busy station
All bubbling over with glee.

But the porter so busily "By your leave" calling
Thinks Christmas a bit of a bore,
And the things on his truck seem in danger of falling
Right over each side to the floor.

But duty is duty and he will not shirk his,
And his truck-load he pushes or drags,
Consisting of hampers, and pheasants, and turkeys,
And boxes, and bundles, and bags.

But when Christmas finally makes them too busy
And porters are run off their legs,
The kind station-master, a thoughtful man is he,
For extra men earnestly begs.

And in this small picture you see them all coming
In long-drawn-out, regular rank,
Their feet on the platform are thudding and drumming,
Their truck-wheels go clanketty-clank.

There are twenty-five of them, at least so I make it,
I wonder if you will agree!
Take the book on your lap, don't drop it or break it
And count just how many you see.

JESSIE POPE.

WEST TO EAST COAST EXPRESS (Lancashire and Yorkshire Railway).

This well-known train runs between Liverpool and Newcastle. It is shown picking up water at speed at Walkden.

FROM AN 1839 TIME TABLE OF THE THEN GRAND JUNCTION, BOLTON, AND NORTH UNION RAILWAY COMPANIES.

Railway Carriages, Old and New

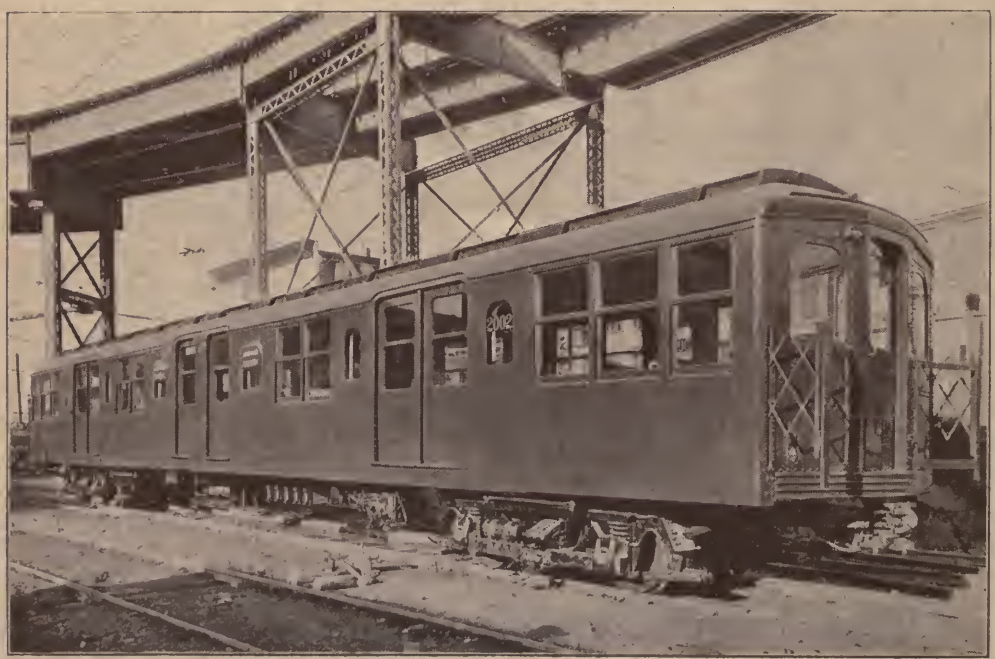
ALTHOUGH railways were something of a novelty until almost the middle of the nineteenth century, those who were responsible for their working and management were more inclined—in traditional British fashion—to adapt previous methods than to devise something more suited to the new means of transit. There is as much difference between the "Experiment," the first real passenger carriage to run on British railways, and the modern railway vestibuled coach which runs from London to the great cities of Scotland as there was between the wooden-wheeled, springless cart of the Saxons and the celebrated stage coach of 1825. At this period the coaches, after humble beginnings, had arrived at such perfection that the wiseacres of those times thought further improvement in travel impossible. Not only were the vehicles themselves well-turned out in every particular, but the whole coaching service was well organized; the stage coach ran to a time-table just like the modern railway, and unless the weather was very bad the departure, arrival, and passing times were usually kept to the minute.

After all, it is not difficult for us to see that there was some excuse for the faith our Georgian ancestors placed in their picturesque mail coaches, for the "Experiment," which was built for the Stockton and Darlington Railway, was not an attractive vehicle; it was like a rough log-cabin on wheels; there were no springs for either axles or buffers, and the windows were without glass, being merely shuttered. No wonder our forefathers preferred their coaches to this travelling shanty!

When people grew more accustomed to railways, things improved considerably, although it was long before the railway carriage of the present type was seen. For many years it was just a body and floor with wheels attached; there was not much difference, except in points

THE "ROCKET" WORKING ON A COAL RAILWAY IN CUMBERLAND.

of detail, between the passenger coach and the goods wagon. The carriages of early days were small four-wheel vehicles, fitted with springs, buffers and lamps which would appear very primitive to us; the body was needlessly small, as the designers in the first part of the reign of Queen Victoria tried to copy the old coaches as closely as they could; they seem to have had the idea that such a practice would give confidence to nervous people who disliked or were frightened at the thought of railway journeys. Traces of the old coach may still be observed in the external mouldings on even comparatively modern rolling stock. The first real improvement came in the 'seventies, when the bogie carriage was put into service. As may be imagined, there was a limit to the length of the carriage, owing to the curves which had to be traversed; various expedients were tried in order to overcome this difficulty; radial axle boxes were fitted, and sometimes the middle pair of wheels in six-wheel coaches was allowed considerable play. But these devices were merely makeshifts; the appliances were not in themselves satisfactory, and the demand for longer and longer vehicles grew more insistent. In England the average six-wheel carriage measures about thirty feet in length, and the four-wheeler is a little less. Some of the Continental lines have managed



A STEEL CAR USED ON THE NEW YORK UNDERGROUND AND ELEVATED ELECTRIC RAILWAYS.

[*Topical.*

A GREAT WESTERN ALL-STEEL TRAIN.

The only woodwork is on the door, and this is specially treated with a fireproof mixture. The flooring is asbestos.

to build carriages longer than these, which have only four wheels; vehicles of this kind may be seen upon the Northern Railway of France, where the coach has eight compartments against the English five or six—in fact, the Paris-Orleans Railway has some four-wheel carriages with no fewer than nine compartments.

While there is not much fault to be found with the riding of carriages of this kind at moderate speeds, it was felt that something better was needed for expresses; besides, the coming of the dining-car made a carriage of from sixty to seventy feet long not merely desirable but necessary. For some years the London and North Western and Great Northern lines experimented with eight-wheel non-bogie carriages, but after exhaustive trials it was found that the bogie coach, though rather heavier, possessed so many advantages over the rigid vehicle that it soon became the standard method of construction all over the country. The now well-known Pullman cars were brought over from

RESTAURANT CAR ON A LONG-DISTANCE TRAIN, SOUTH AFRICAN RAILWAYS.

Dust is a great nuisance in South Africa, and special arrangements have to be made to prevent it from entering through the ventilators.

the United States to England in 1875, and first appeared in regular service on the Midland Railway; about the same time this company was also turning out remarkably fine eight- and twelve-wheel bogie carriages of the ordinary English compartment type, but of generous dimensions, from its own works at Derby. Pullman cars had been in use across the Atlantic for about fifteen years before, but the adoption of the bogie for railway work goes back far beyond this. The word "bogie" simply means a small trolley, and a bogie carriage is one which is carried upon two such trolleys, having four or six wheels each; the body of the carriage is attached to the trucks by means of massive centre pins, about which the truck can move in a circle, thus adapting itself easily to the most severe curves. So flexible is the carriage that it can traverse any curve that a four-wheel wagon can travel round, if there are no obstructions such as platforms or other trains in the way.

It must not be supposed that the British main line carriage is in any way a copy of the American vehicle; the British coach is built, as a rule, with separate compartments (except in the case of restaurant

cars), while the American car is generally open from end to end. There are other differences of a structural nature; the American car is divided into trucks and body, but the English carriage consists of a floor to which are attached the wheels below and the body above. In recent years some slight modifications have come into use; the practice of using nothing but steel in the construction of passenger cars is tending to bring the British production nearer to the American design than was formerly the case.

All this time, other mechanical improvements were being made. The early railway carriage was simply a covered wagon (not always covered for third-class passengers); it had cushioned seats, spoked wheels, scanty springs, and very small windows. Gradually, various refinements were introduced: the continuous brake was fitted to all passenger-carrying vehicles, proper lamps were fitted, and springs were devised which really did ease one's bones over the rougher parts of the line. Nowadays, the main line carriages of any great railway

A DINING CAR ON THE GREAT WESTERN RAILWAY.

are fitted with every comfort and convenience that the most fastidious can wish for: the wheels are of the Mansell, or solid steel disc type; the springs are long and carefully adjusted to the weight they have to carry, with rubber hangers further to minimize the vibration; the floor is double, and packed with material to deaden the noise; the windows are large and made of plate glass; and the lighting, whether it be gas or electric, enables one to read the smallest print in comfort. The old-fashioned foot-warmer is almost a thing of the past, as the compartment is kept warm and cosy with steam from the engine's boiler; the decoration is often very artistic, and sometimes, even at the highest speeds, one can forget that one is in a train at all. Mechanically, it would seem that there is not room for further improvement, but the inventor's genius has not been brought up against a "dead-end"; in Sweden ball-bearings, similar to those we know in the bicycle, but larger, are in use and are proving very successful—for one thing, a train of carriages so fitted is much easier to start, which makes it much better for the engine. All sorts of materials have been tried for the wheels: in America they use compressed paper and what is called "compoboard," both of which have given good results. The steel disc wheel, however, is rapidly coming into favour on both sides of the Atlantic, as it is reliable and strong without being too expensive.

[E. N. A.

A TRAVELLING CHURCH, FORMERLY USED ON THE TRANS-SIBERIAN RAILWAY.

AN OBSERVATION SLEEPING CAR, CANADIAN PACIFIC RAILWAY.

The Mansell wheel is still in fairly general use here; it is made of wooden segments of a circle grouped round the axle-boss, and cut to the required size, slightly larger than the tyre, which is then heated to make it expand; while it is still warm the centre part of the wheel is forced home by a hydraulic press, and the complete wheel quickly plunged into cold water. The tyre then cools and contracts, so that it holds the wooden segments in a grip that cannot be loosened.

The last great improvement demanding mention is the introduction of restaurant cars and corridor carriages. The restaurant car is a great convenience to people who are obliged to make long journeys, and it also saves considerable time in the running of the train. Formerly the Scotch expresses used to stop for no less than twenty minutes on both up and down journeys to enable the passengers to obtain a meal; the West Coast train stopped at Preston, the Midland at Normanton, the East Coast at York, and all the Great Western trains at Swindon. Nowadays, the dining car will supply the traveller with a meal similar to that he would get in the best hotels, freshly cooked on the train. In addition to regular meals, the restaurant car can serve tea and other light refreshments, and is thus able to relieve the crush at wayside refreshment rooms when an important main line express stops. The corridor carriage is another great improvement: not only does it provide lavatory accommodation for all compartments instead of one or two as in the older vehicles, but it ensures the lonely traveller against the risk of assault and robbery; there was often danger for a

passenger who might be shut up for two hours or more with a criminal or a lunatic. At the present day, nearly all important expresses are vestibuled; that is to say, the carriages are connected, one to the other, by a covered gangway called a vestibule. This arrangement enables all passengers on the train to go to or from the restaurant car for meals; from the Companies' point of view, too, it is useful, for collectors are thereby able to go along the whole train, and collect and examine tickets; this custom saves a great deal of time at stations, and it also prevents dishonest people from travelling "first" with third-class tickets. On the night trains sleeping saloons are run for the benefit of those who are compelled to make long journeys in the dark hours: in these vehicles every precaution is taken to deaden the sound of running and to give the easiest possible riding; india-rubber is liberally used, and the floor is thickly packed with felt.

In some cases a real bed is provided for the passenger, instead of a bunk like those on board ship. This does not matter very greatly, for the bunks are fitted with spring mattresses, and are in every respect like beds in a house.

The ordinary main line carriage, with its corridor and vestibules, is hardly inferior to the restaurant cars. Bogie stock is almost universal all over Great Britain; as a general rule, the carriages are eight-wheelers, although there are a number of examples of twelve-wheeled stock about; of the latter type, the East Coast Companies (the Great Northern, North Eastern and North British) have a large number in use, but the West Coast (L. and N.W.R. and Caledonian), the Midland, the Pullman cars running on the Brighton Railway, and the Caledonian Railway's very fine Grampian stock must also be mentioned. The London and South Western only uses eight-wheel bogie carriages on its expresses, restaurant cars included; standardization has been carried out very thoroughly on this railway, so that any carriage can be sent to any part of the system; the main line stock is not necessarily confined to the main line. This is very useful when through carriages have to be run from London to some small country branch. Two of the finest examples of eight-wheel bogie coaches are to be found on the South Eastern and Chatham and Great Central Railways, the latter being the heaviest vehicles with this number of wheels now running in England.

The carriage stock on short-distance and suburban trains has also been much improved in recent years; as a rule, with the excep-

A 70-FEET RESTAURANT CAR, GREAT WESTERN RAILWAY.

A DINING SALOON, GREAT NORTHERN RAILWAY.

A FIRST-CLASS CARRIAGE ON THE WESTERN STATE RAILWAYS, FRANCE.

A SALOON CARRIAGE ON THE GREAT INDIAN PENINSULA RAILWAY.

tion of the absence of corridor carriages and dining-cars, the vehicles on these services will be found equal in most respects to the best main line stock. The use of electric light in railway fittings has enabled the designers to fit compartments in some cases with four lights instead of one central lamp; it is thus much easier to read in trains than before. Even in local trains, bogie carriages are almost universal, while the lighting, heating and ventilation are just as good as on the expresses.

The Great Northern Railway has in service a very interesting kind of suburban train: to save weight and length, two carriage bodies are mounted upon three trucks instead of four, the central truck coming under the strong fixed coupling which connects the two structures. These trains have been found very useful on the line from King's Cross to Moorgate Street, where the Great Northern runs over the Metropolitan Railway. Owing to the fact of the lines being underground, it was impossible to lengthen the platforms, even if cost had not to be considered; but the number of passengers had increased so much that something had to be done; as a consequence, the twin-bogie carriage was built, and gave accommodation for many more passengers, while it also added to their comfort by carrying them very smoothly.

A SLEEPING SALOON, WITH MOSQUITO NETS, NIGERIAN RAILWAYS.

In addition to the Companies' own stock, there are a large number of Pullman cars running in this country: the London, Brighton and South Coast, Caledonian, and South Eastern and Chatham lines have these cars running regularly. They are very fine vehicles and only differ from those used in Canada and

FIRST-CLASS DRAWING-ROOM CAR ON THE SYDNEY MAIL TRAIN, QUEENSLAND RAILWAYS.

the United States in size, as the loading gauge in those countries is considerably greater than in England. There are many wonderful trains "over there"; some even excel the best British trains in minor luxuries, for we find tape machines which give all the latest news, libraries, and bathrooms; such things, though quite possible on British lines, are not necessary on a three-hour journey, though very convenient on one that may take anything from thirty hours to six days. The buffet parlour car is quite an old institution on American trains: very often the rear part of the car is left open and is called an "Observation" car, while the covered part of the carriage is furnished like a lounge and includes a refreshment counter and a bookstall. The same type of coach may be found on the principal lines in the United States; nor are these and other refinements confined to the lines running out of New York; they are also found in the Wild West, on the Southern Pacific and Santa Fé railroads.

Although journeys on the European Continent are not so long as in America, passengers have to spend so many hours in the train that travel comforts are very desirable. The International Sleeping Car Company runs dining and sleeping cars in nearly all countries; in fact, some of the more important expresses are made up entirely of this Company's stock, trains like the Orient Express, the Sud Express, and so forth. The picture of a first-class bogie carriage belonging to the Western State Railways, of France gives a very good idea of the appearance and type of most Central European stock; the outside seems very plain and dull to our ideas, but inside every comfort is provided and the riding of main line carriages in France, Germany or Italy is invariably good.

As befits a railway performing an important national service we

find that the Great Indian Peninsula Railway is very well equipped with modern coaching stock; the carriages on this railway are built in the main on British designs, with suitable adaptations for the very hot climate of India; the principal trains always have bathrooms, and the beds are provided with mosquito nets. Nor do Australia and New Zealand lag behind, as will be seen from the photograph of a car on the Sydney mail train. The South African Government Railways, in spite of their narrow gauge of 3 ft. 6 in., manage to provide the passenger with everything he would get in England or India; a glance at the dining car running on the main services shows us that our South African cousins can congratulate themselves on an efficient and comfortable railway service. In that country dust is a great nuisance, so special arrangements have to be made to prevent it from entering through the ventilators.

Many people are travelling by aeroplane nowadays, but the extra time that may be taken on a journey by rail is more than balanced by the greater comfort and certainty of the train, where you can be kept warm, well fed, and find a bed, if necessary, for a long night journey.

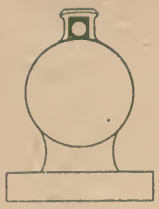
BASIL MERCER.

[*Fleet Agency.*

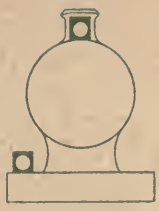
A CLEVER CATTLE GUARD IN USE IN THE WESTERN STATES OF AMERICA.

As a cow straying along the line steps on to the wooden platform, this tilts up and prevents further wandering.

No. 1.
Express passenger train.



No. 2.
Ordinary passenger train.



No. 3.
Express fish, fruit, and other non-passenger trains fitted with continuous brakes. Also empty passenger trains.

No. 4.
Express goods, fish or meat train, with goods vehicles.

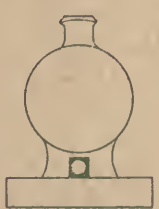
STANDARD RAILWAY LAMP CODES.

Railway Head Codes

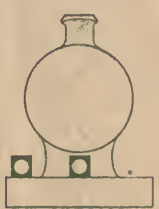
RARELY is an engine seen at work without at least one lamp, lighted or unlighted, in front, or some kind of disc or board; and frequently there are two or more. These, by their number and arrangement, form what are known as "head codes," and they serve some very useful purposes. Sometimes the lamps or discs show only what class of train is coming; that is, whether express, slow passenger, empty train, light engine (that is, an engine running by itself), or some kind of goods train. In other cases they show where a train is going or where it is from, or what route it is taking. Such indications are most important, for by their aid railwaymen can often identify a particular train, even if it is late or out of its proper order, and signalmen know what to do with trains at junctions or whenever it is necessary to shunt one train out of the way of another.

Every railway has its own system of head codes, but there are nine codes which are used by nearly all with the same meaning. This standard code was introduced recently, because so many railways now

No. 5.
Express cattle or ordinary express goods train.



No. 6.
Light engine, or engine and brake van.



No. 7.
Goods or mineral train conveying through loads.

No. 8.
Through goods train stopping intermediately.

No. 9.
Ordinary stopping goods train.

STANDARD RAILWAY LAMP CODES.

send trains over other lines, and the fact that a particular code on one railway had a different meaning on another railway caused difficulties.

These standard codes indicate only the classification of a train, and do not show where it is going or where it has come from. But many railways manage very well with these only, the railwaymen having to depend for other information upon the time-tables and the telegraphic messages sent by the signalmen. In these codes lamps only are used, all showing white lights, except that on a few lines a white disc is used in the same positions in daylight. Generally, however, the lamps are also used during the day, though they are not lighted unless long tunnels have to be passed through.

The standard codes are shown by the diagrams on the previous page, and it will be sufficient to state their meanings—

No. 1.—Express passenger train.

No. 2.—Ordinary passenger train (stopping, local or branch).

No. 3.—Express fish or fruit train composed of passenger vehicles, or goods or mineral trains fitted with vacuum brakes. Also empty passenger trains.

No. 4.—Express goods, fish or meat train composed of goods vehicles ; also Class A cattle or goods trains.

No. 5.—Express cattle or ordinary express goods train, Class B.

No. 6.—Light engine, or engine and brake van.

No. 7.—Goods or mineral train conveying through loads.

No. 8.—Through goods train, stopping intermediately.

No. 9.—Ordinary stopping goods train.

On many railways, however, the traffic is so complicated that further information is necessary, and several lines have much more elaborate codes for their own purposes. As a rule, white and green lights only are used at night, and in the daytime discs or boards are placed on the front of each engine.

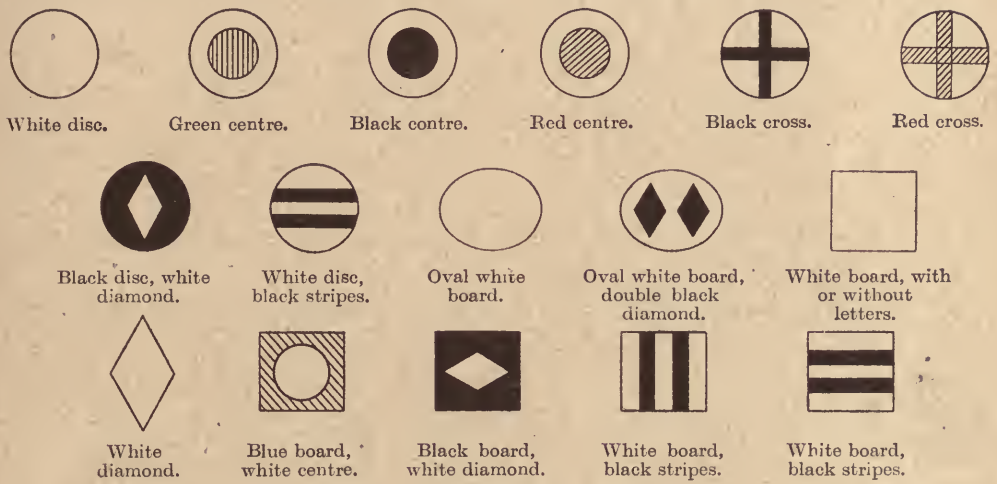
On the Great Eastern Railway a white light at night corresponds to a white disc in daylight, and a green light is represented by a green disc with a white rim so that it shows up clearly against the black of the engine front. On the South Eastern and Chatham Railway a white disc with black cross corresponds to a green light at night. With these systems the day codes correspond with the night codes, except that discs are used instead of lights.

But there are several railways where all sorts of other discs and boards are used, and as these cannot be represented in the same way by

lamps it follows that the day codes are quite different from the night ones. For example, an engine may carry one square board with black stripes, or perhaps two or three discs of different kinds, and at night it will have quite a set of white and green lights.

In early days the idea was that each train route should have its own particular disc or board, but nowadays it is often necessary to use two or three together to provide sufficient variations.

Discs with a red centre are sometimes used on single lines, and at night one or two railways use a red light then, though a red headlight is very rarely used under any other circumstances. A few lines use



ENGINE DISCS AND HEAD BOARDS.

blue or purple lights for certain purposes, but white and green are the rule, and some railways use white only.

The Caledonian Railway has a system entirely its own. A device having two semaphore (or signal) arms painted white is fitted on the front of the engine, and by placing the arms in various positions a large number of indications can be given. For further variety the whole device can be placed in another position on the engine.

Diagrams of a few typical codes are given, but these are designed to show the lamp and disc positions, and it is only now and then that so many discs and boards will be used at once.

On the Great Eastern Railway discs can be placed at the foot of the chimney, over either buffer, or in the middle of the buffer beam, and the same positions are provided for on many other lines. On the

London and South Western Railway, discs can also be placed at the sides of the smoke-box, and on the London, Brighton and South Coast Railway and one or two other lines discs can be placed one over another, or two can be placed side by side over either buffer. Where long tunnels have to be passed through one or more lamps are placed in positions not occupied by discs during daylight.

Some of the Great Northern engines have a bracket so that one lamp can be placed above another on the chimney.

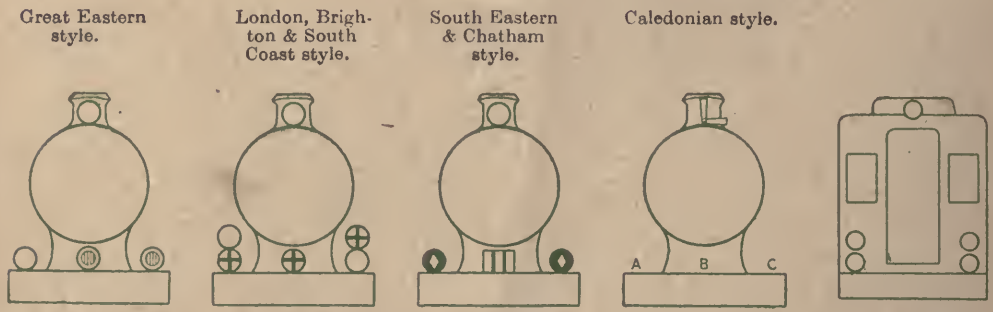
At the end of each tender, or on the bunker of a tank engine, brackets are provided so that the discs and lamps can be placed in the proper positions when running backwards.

Shunting engines on some railways have a white and a red light at each end.

Finally, we must refer to the head codes used on the electric railways, and one of the diagrams below shows the arrangement adopted by the District Railway. There are five lamp positions, and at each of these an electric light is fitted in a casing that is painted white. Only very exceptionally are all five lamps used at once, and those not required are switched out and a dark cover placed over their casings. Therefore in the tunnels and after dark the lights constitute the head codes, and in daylight the white casings of the lamps in use serve the same purpose.

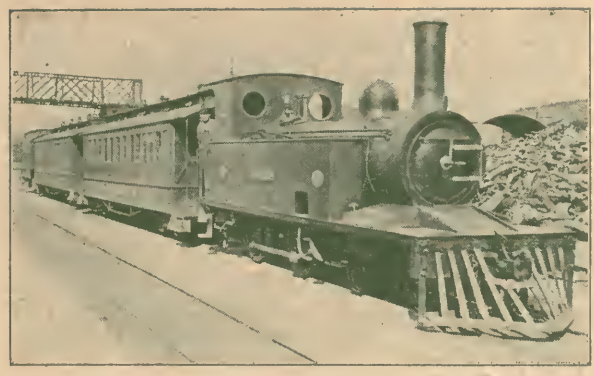
Besides the systems of head codes described there are a few others, but enough has been said to show how interesting the subject is and what a lot a train will tell you about itself if you will only take the trouble to learn its language.

J. F. G.


Great Eastern style.
London, Brighton & South Coast style.
South Eastern & Chatham style.
Caledonian style.
A
B
C
White discs ; green discs with white rim.
White disc, black cross.
Various boards and discs.
Semaphore codes. Device can also be placed at A, B, or C
Electric trains, District Railway.

SOME TYPICAL CODES TO SHOW DISC OR LAMP POSITIONS.

DRIVER AND FIREMAN AT WORK ON AN EXPRESS LOCOMOTIVE.



[*H. Fayle.*
ON THE CAVAN AND LEITRIM RAILWAY, IRELAND.

Plucky Little Arlington

"OH, here you are, Den! I've been looking for you all over the shop. Have you seen little Arlington?"

"No, what's the matter with him?"

"Well, nothing really—only his uncle's written to say he'll have to spend his holidays here again. It's a bit rotten, isn't it?"

"Oh, yes, I suppose so," Den answered, turning the leaves of the Latin grammar a trifle impatiently; "but I don't see what it's got to do with us."

"Only this; I was thinking we can take home pretty nearly anyone we like, and we always have such a ripping time. Why not take the little chap and give him a taste of it?"

"What!—that rotten little spoil-sport? Not if I know it."

His brother turned to the window and stood looking out, a puzzled frown on his face, and Den went on: "Why, man, what can you be thinking of? He'd be just one too many in all our expeditions, and I'll be bound he couldn't climb for toffee, and would get tired in a mile. Surely," he added, after a pause, during which he wrote two words and crossed them out, "there's someone else he might go with? Why should we be pestered with him?"

"You see, it's the last day of the term, and most fellows have made their arrangements. It's not everyone, you know, who can do what they like as we can."

"Oh, all right! have it your own way. You always do, though, somehow." He spoke in a half-vexed tone, but Derry turned from the window with a laugh.

"Good man," he cried cheerily, slapping his brother on the back; "we've got so much, you see. I'll go and tell him."

Had Den seen little Arlington's face light up when Derry asked him if he'd like to come home with them for the holidays to Diemont, he might have felt that it was worth the trifling inconvenience.

"I should love to come, Freer, if you're sure I shan't be in the way."

"Oh, no—not a bit. We'll put you in a band-box if you are. You'd better trot along and get a permit from the Head," and Derry swung off to the cricket field.

The next day school broke up and all the boys departed. The Freers were among the first to leave, and with them went little Arlington, his face one beam of delight.

"It's awfully good of you to take me, you know," he said to Den as they stood together at the carriage door.

"Oh, it was all Derry's doing; you must thank him," the big boy answered rather shortly. Then, looking at his companion's radiant face, he added: "I hope you will have a good time with us, youngster—only, of course, you can't expect to go about with us always."

"Of course not—I don't expect it. But anything's better than school."

It was a long journey, and night came on before they reached their destination. At the little Welsh station, Sir Denzil met them with the carriage, and little Arlington, whose people lived in a London suburb, revelled in the luxury of the country drive as they bowled along.

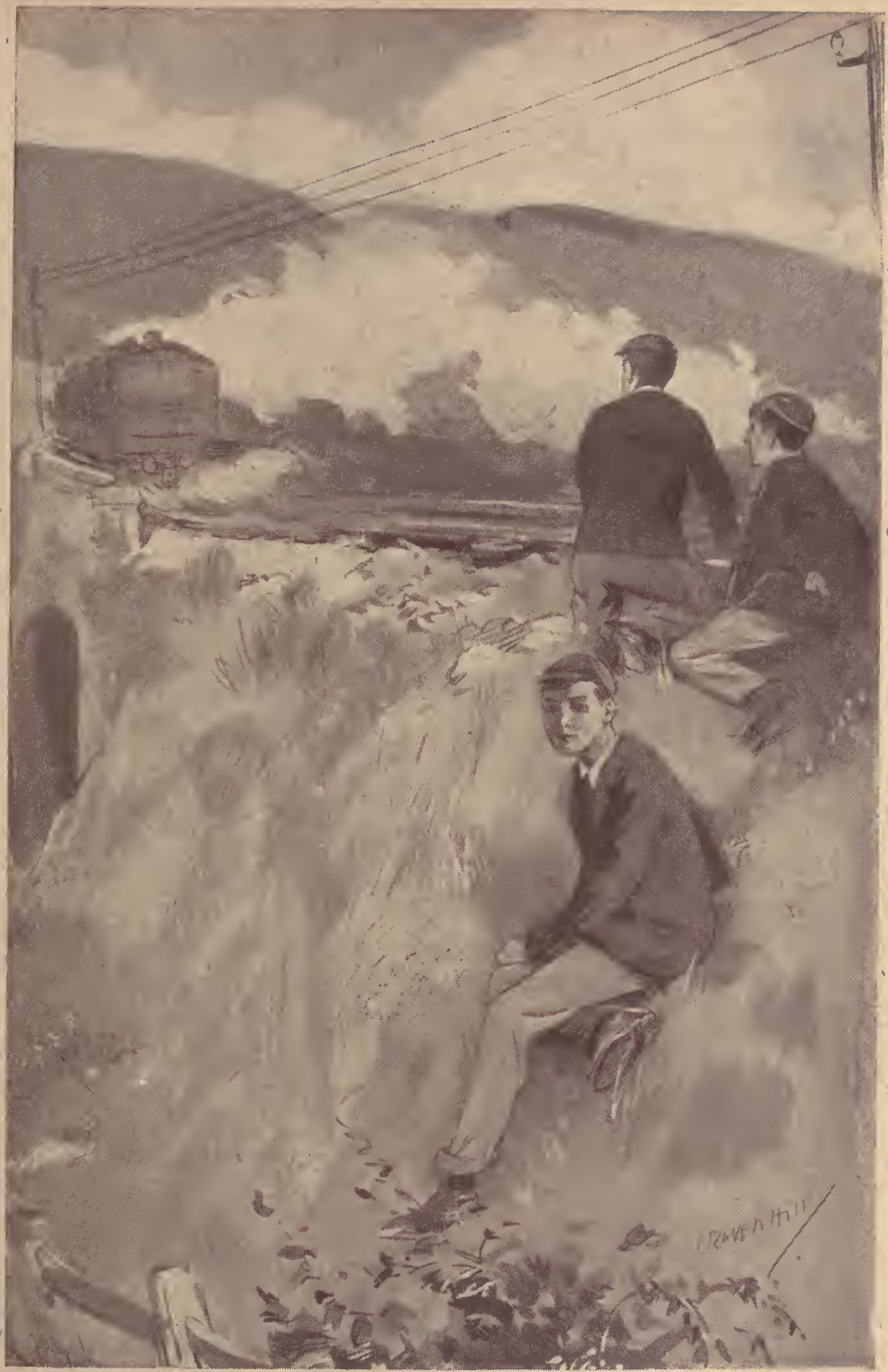
Sir Denzil greeted his sons cordially and the stranger kindly.

"I hope you'll be able to get along all right, boys," he said, presently. "I find I shall not be able to be with you much; I have a lot of business which will detain me in Fleetcar a night or two most probably."

"What a bother! It's much jollier when you are with us, dad!" Derry answered warmly; "but, of course, we shall be all right alone."

"Yes, I thought you would; but there's always old Andrewes, he'll look after you and arrange everything you want."

That night little Dick Arlington, sitting at the elegant dinner-table (for the boys dined with their father when he was at home), thought he was in a dream. The great room, with its wide fireplace and long table covered with shining silver and glass, was perfection in his eyes,



"THE RAILWAY WAS A CONSTANT SOURCE OF INTEREST TO THE THREE BOYS."

and his heart was full of gratitude towards Derry, who had noticed his loneliness, and thought it worth while to pause on his merry way through life to give a little pleasure to a fellow-creature.

As for Den, if he didn't approve of his brother's proceeding, he was too much of a gentleman to show it by word or deed, and many a jolly time they had in the weeks which followed. Such climbs and scrambles up the beautiful Welsh hills, such boating expeditions on the great tarns, and numberless picnics. Sometimes Sir Denzil went with them, but more often he had business in Fleetcar, and then one or other of the boys drove them down to meet the train by which he returned.

The railway was a constant source of interest to the three boys. Many and many a time they would make their way down the hill to see the express go by and to watch it make its way round the great curve towards the distant headland.

One day, towards the end of the holidays, they were returning from a long day in the mountains. It was very hot, a close, sultry kind of heat, with thunder threatening. The boys did not hurry, they knew they had plenty of time to get home to dinner, so they strolled along leisurely.

"I'm sorry the holidays are so nearly over," Dickie remarked presently. "You fellows have been good to me; I've enjoyed myself no end.

"Have you?" laughed Derry. "That's right."

"There's only one thing that bothers me," pursued Dickie, "and that is that I can't possibly pay you back for all this. But I shan't forget it," he concluded earnestly; "and some day, perhaps——"

"When you're Grand Jam of something or other you'll ask us to your palace, and feed us on roast wild cat! All right, Dickie, we'll wait."

"No, I didn't mean that at all," the younger boy laughed. "You're always chaffing, Derry."

"Laugh and grow fat!" quoted Den. "I often tell him he'll be as round as a tub when he gets old."

"Who cares?" cried Dickie, and struck up in a very shrill treble, "For he's a jolly good fellow."

Derry promptly fell upon him, and with a dexterous turn sent him rolling down the hill nearly on to the railway line, which ran at the foot. Dickie scrambled to his feet, vowing vengeance, and began toiling up again, but had scarcely taken a dozen steps before the ground began to heave under him. He clutched wildly at a piece of rough sedge grass as he

was flung on his face ; the whole world seemed to be moving and shaking. Then came a crashing roar, the like of which he had never heard in all his life, and he became the target for a shower of small stones. He was not a very big boy, and he clung desperately to his tuft of grass, his eyes tightly shut.

When he opened them again all was still. Up the mountain his friends were both on the ground, but Derry was kneeling up, his arm flung about a boulder, looking, not at little Arlington, but away down the line. Dickie turned and looked, too. There, where it had all been clear rails before, was a great heap of earth and stones that had come slithering down the mountain-side, just missing the boy. A sudden thought occurred to him, and he looked the other way. Ah ! his ears had not deceived him. It was an engine's whistle he had heard, for round the northern spur of the hill dashed the express from Fleetcar. Derry was shouting from the top, but Dickie could not hear what he said. One thing only he understood, and that was that neither of his friends could reach the rails in time, and unless he could warn the engine-driver the train would run into the landslip, for from the cab of the engine they could not see it.

Down the hill raced little Arlington, tearing off his coat as he ran, and waving it wildly. Would they see him ? Oh ! would they ? Along the rails to meet the rushing train—it was harder going here, but he kept on valiantly, stumbling on the sleepers. He was down now, and had given his ankle a nasty wrench. Never mind ; up and on again. Ah ! the fireman was leaning out !

" Get off the rails ! " he shouted. " What's up ? "

" Something on the line—at the bend," gasped Dickie, and tumbled over on the grassy bank, quite spent, as the express rushed by.

Rushed by ! But the driver knew now, and slowed up, finally stopping the right side of the bend, where Derry and Den were waiting.

" What is it ? What's the matter ? " all the passengers were asking, and Sir Denzil himself was one of the first to get out.

" Why, Derry, what's this ? " he cried. Den was talking to the engine-driver.

" It's a landslip, dad ; I thought it was an earthquake, and we weren't near enough to get there in time, but little Arlington did. I think I'd better go along and see how he is," and away went impetuous Derry.

" I'll come, too," said Sir Denzil, striding after him, but he had to stop to answer anxious inquiries from the passengers.

"There's no damage done to the train, but we shall have to wire for assistance. If you are in a hurry you'd better walk, I think. It's not far."

At length he came to the boys; Dickie's face was hidden on his friend's arm.

"He's hurt his ankle, dad." Derry looked up with a worried face. "However shall we get him home?"

"I'll carry him, if that's all," Sir Denzil answered, "but it's probable Andrewes will hear of the accident and send the carriage. Let me look at the ankle."

It was badly sprained, but a rest would soon put it right.

"Can't we get away, Derry?" whispered little Arlington; "those people are coming."

The passengers, some of them, had got at the rights of the affair and were coming up to make a fuss over the "charming little boy," as the ladies expressed it. Sir Denzil looked at Dickie with a twinkle in his eye, but seeing he could not stand much, he lifted him in his arms.

"All right, old fellow," he said, "we'll get home across country and doctor the ankle. Come along, Derry; Den will come on with the train. I expect. You might just tell him we're going."

When Den came in, late in the evening, full of excitement, Dickie was on the sofa with his foot bound up. He was eating peaches and looked blissfully happy, while Derry sat beside him, with Sir Denzil near by.

"Come along, my boy, and get your dinner," he cried. "I expect you're hungry. Well, have they cleared the line?"

"Yes, cleared enough to get the express through, but they've only just done it, and most of the passengers had to walk. I say, dad, they say it was an earthquake. There must have been one somewhere on the Continent, and we felt the shock here. Is that possible?"

"Oh! quite. I suppose we shall get particulars in a few days. Thank God, there's no more damage done. You three might easily have been under that mass of earth."

Den looked up suddenly from his dinner to the invalid on the couch.

"You were talking about paying us back, Arlington, but I don't think we need wait until you are a Grand Jam," he said. "They say if the driver had not been warned, at the speed the train was going, the chances are ten to one everyone would have been killed."

"Then it's lucky for us, Den, Derry brought him here for the holidays. God bless little Arlington!" said Sir Denzil.

M. E. Heward.

By courtesy of the] [*Canadian Pacific Railway.*

THE PRINCE OF WALES AS DRIVER OF THE CANADIAN PACIFIC ROYAL TRAIN DURING HIS VISIT TO CANADA IN 1919.

Locomotives of the Empire

ALTHOUGH the British Dominions are so large, only India has anything like the population of the Homeland, so that while their chief railway routes are very long, there are not so many separate railways, nor are the numbers of locomotives, carriages, and wagons so great. Yet these countries have very fine railway systems, most of them constructed and worked in much the same way as are those at home. It is only in Canada, in fact, that the railways are not British in style, for the reason that the great Dominion is linked with the United States and its lines and engines are more American than British. In few parts of the Empire are there big works able to build anything like all the engines, carriages and wagons required, so that most of these are built in Great Britain and sent out by sea.

In the Home Country many bridges, tunnels and stations were made fifty years or more ago by engineers who had no idea that later these works would prevent us from making our engines and trains as big as we should want them; but in other parts of the Empire this hindrance has not been serious. Therefore on many of the overseas railways engines are used which would be far too big to run on

our own railways ; and seeing that some of them have to cross steep mountain sections many special classes quite unknown to British boys are to be found.

In India nearly all the railways belong to the Government, though most of them are worked by British companies. There are two main kinds—the broad-gauge lines, where the rails are laid to a gauge of 5 ft. 6 in , and the metre-gauge railways, with a few narrow 2 ft. or 2 ft. 6 in. gauge lines.

On the broad-gauge railways nearly all express passenger trains are hauled by big 4–6–0 tender engines, with a good many 4–4–0's which still take a share in the traffic. Between the great cities of India a number of important express trains are run ; some of these have very fine carriages, and the engines have to take big loads and to run fast. Here and there, however, are mountain sections, and to get the trains up these steep grades special engines are used, such as the big 2–8–4 tank engines of the Great Indian Peninsula Railway. For the goods trains, with loads of wheat, timber, cotton and other articles which are usually sent in big train loads, 2–8–0 locomotives are used. The metre-gauge lines have similar engines, except that everything is on a smaller scale, and many of the goods engines are 4–8–0.

A 2–8–0 LOCOMOTIVE, GREAT INDIAN PENINSULA RAILWAY.

[*C. F. Dewey.*

A 4–6–0 EXPRESS LOCOMOTIVE, NEW SOUTH WALES GOVERNMENT RAILWAYS.

Australia has a somewhat strange combination of railways. In early days each State laid out railways according to its own ideas, and without considering what was to occur when the lines of one State should become connected with those of another. The result is that three different gauges are used, and in journeying from the chief city of one State to that of another it is frequently necessary for passengers to change carriages, and for goods to be transferred from one wagon to another at least once, if not twice.

Thus in New South Wales the gauge is the same as in Great Britain, 4 ft. 8½ in.; in Victoria it is 5 ft. 3 in.; South Australia has part of its lines 5 ft. 3 in. and part 3 ft. 6 in.; while Queensland and Western Australia both have the 3 ft. 6 in. gauge. The great new Trans-Continental Railway is built to the 4 ft. 8½ in. gauge. But while these differences cause much trouble for traffic passing from one State to another, there are long distances to be worked on every main route—for Australia is a very great place, a continent, not a country—so that big engines are required in many parts. Express trains that are far from light have to be worked over mountain sections with steep inclines; and goods trains are generally long and heavy.

Most of the express passenger trains are pulled by large 4–6–0 superheater engines; one of those on the New South Wales Government Railways is shown. It will be remembered that the gauge in this State is 4 ft. 8½ in., and some of these engines which were

CORRIDOR TRAIN RUNNING BETWEEN DURBAN AND JOHANNESBURG, SOUTH AFRICAN GOVERNMENT RAILWAYS.

being built in England were sent to France during the War instead of going out to Australia. For heavy goods trains 2–8–0 engines are chiefly used. On other Australian railways the engines are, of somewhat the same style, but those for the 3 ft. 6 in. gauge are, of course, smaller.

Tasmania is a small State and an island, so that it does not matter much that it should have the 3 ft. 6 in. gauge; but it has some steep mountain lines where very remarkable engines are used. That illustrated at the bottom of our first page is a Garratt articulated express engine, and you will search in vain to find an engine like it in Great Britain, though many have been built at home for various foreign railways.

The idea of the design is that the boiler is supported between two bogies so that it can be made larger than would be possible with an ordinary British engine. Each bogie has an engine and wheels, both carrying and coupled, and between them they support the boiler. They can, however, swing on pivots in going round sharp curves. On each bogie there are water tanks, so that a separate tender is not required. It seems rather a puzzle to express the wheel arrangement

by numbers, but it can be best put down as 4–4–2–2–4–4. There are also some 2–6–2–2–6–2 engines, with smaller wheels, for goods traffic.

New Zealand is a land of mountain lines, and though the gauge is only 3 ft. 6 in., the Dominion has some very big 4–6–2 engines, besides a number of special and very powerful tank engines for use on the mountain sections. In one or two places there is a centre rail; the engines have horizontal wheels which grip on either side of this rail and thus help to work the trains up the steep grades. This is known as the Fell system; below is a view showing a train being taken up the steep Rimutaka incline by four Fell engines, placed here and there in the train, instead of all in front or behind.

South Africa is also a 3 ft. 6 in. gauge country, and this applies all the way from Cape Town up through Rhodesia, as well as in the various countries through which the Cape-to-Cairo express will pass when the wonderful line of railway is completed to join up with the Egyptian lines. But although the gauge is only 3 ft. 6 in. some very big engines are used. Indeed, many are much larger than any on the 4 ft. 8½ in. in Great Britain; they need to be, on account of the steep mountain grades over which heavy trains have to be pulled in so many places.

By courtesy of the [*New Zealand Government Railways.*

POWERFUL TANK ENGINES, WORKING ON THE FELL SYSTEM, TAKING A HEAVY TRAIN UP THE RIMUTAKA INCLINE, NEW ZEALAND.

The incline is 3 miles long, rises to a height of 1,144 feet and has a gradient of 1 in 15.

4–8–2 SUPERHEATER LOCOMOTIVE, SOUTH AFRICAN GOVERNMENT RAILWAYS.

Passenger trains, including several expresses which have restaurant, sleeping and special cars, are now generally pulled by 4–6–2 engines of great size and power, and for goods traffic there are enormous 4–8–2 locomotives. In some parts what are known as Mallet articulated engines are used. Under the big boiler are two sets of coupled wheels, each with its own pair of cylinders. The front set is on a movable frame, so that the whole can swing like the bogie in front of an ordinary locomotive, and so, though the engine is so long, quite sharp curves can be rounded safely and easily.

In Rhodesia, Uganda, and also in Nigeria, Sierra Leone, the Gold Coast, and some of the other British Colonies or Protectorates in Africa, 4–6–0, 4–8–0 and other engines are to be found, but they are not usually so big as in South Africa proper.

Canada is, like the United States, a land of big things in railways. Its lines, engines and cars are more American than English. In fact, some of the lines are connected with those in the United States, and certain trains work through over portions of United States railways, so that it would be useless to attempt to make them distinctively British. But while there are many American-built engines in Canada,

HEAVY TANK ENGINE, HAULING TRAIN OVER THE GHAUTS, GREAT INDIAN PENINSULA RAILWAY.

most are built in the railway shops at Montreal, or by private firms, and the engine illustrated on page 5, a huge 4–6–2 belonging to the Canadian Pacific Railway, is a good example of the latest practice. This particular engine, by the way, was used for the Prince of Wales's train during his tour through Canada in the autumn of 1919.

Engines of this class work all the Trans-Continental expresses across Canada, from the Atlantic to the Pacific, except in crossing the

TRAIN PASSING OVER THE VIADUCT, MOUNT LOFTY RANGE, SOUTH AUSTRALIA.

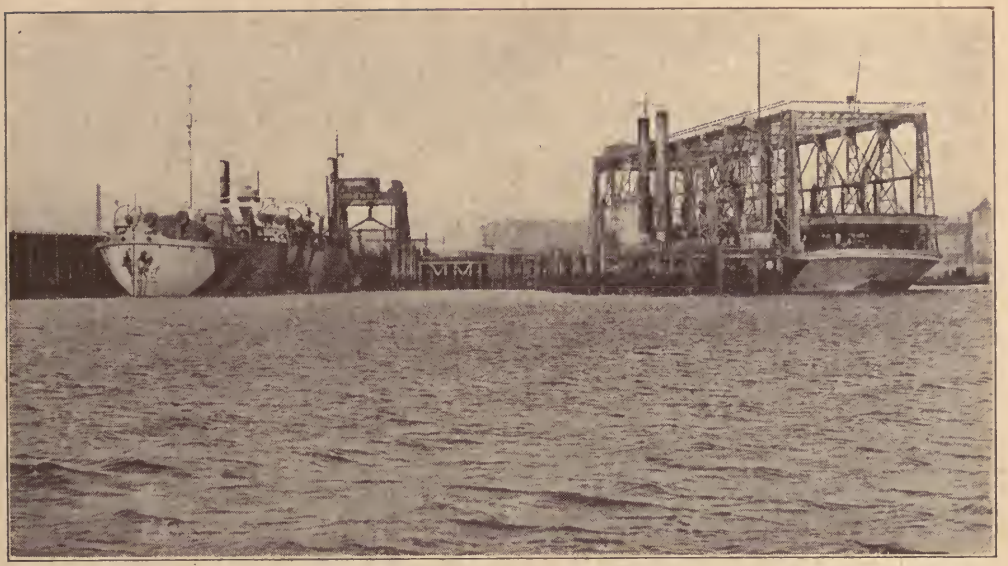
Rocky Mountains, where 2–8–2 (" Mikado " type) and 4–8–2 (" Mountain " type) engines, such as are used for goods or freight traffic elsewhere, necessarily work the express trains, owing to the very steep grades.

It will be seen that the " Locomotives of the Empire " include many engines much bigger than any in use at home, and some of them are of types and designs quite strange to boys in Great Britain.

By courtesy of] *[Sir W. G. Armstrong, Whitworth & Co., Ltd.*

SCREW ICE-BREAKER AND RAILWAY FERRY STEAMER, "PRINCE EDWARD ISLAND."

This fine vessel, 285 feet long, transports trains across the Strait of Northumberland between New Brunswick and Prince Edward Island. The Strait, nine miles across, is often frozen over.



[*Alfieri.*

TRAIN FERRIES LYING ALONGSIDE THE JETTY AT SOUTHAMPTON.

Train Ferries

WIDE rivers, arms of the sea, lakes, and other waterways often place themselves very inconveniently from a railway point of view. Thus, New York is mainly on an island, so that some of the railways have to terminate on the mainland and convey passengers and goods across the water by steamer. Denmark has its railways in several sections on islands or peninsulas. The Trans-Siberian Railway found Lake Baikal very much in its way.

In many such cases the method has been adopted of taking the railway trains on the boats, so that goods need not be unloaded and reloaded, and now, in many parts of the world, special steamers are used for this purpose. Indeed, in Denmark passenger trains are taken in this way, so that travellers need not turn out of a comfortable railway car for a steamer trip of an hour or so.

In America, Canada, parts of Europe, and, indeed, all over the world, train ferries are employed. Most are very big and fine vessels capable of taking a complete goods train at one operation, but a few are comparatively small affairs.

Great Britain had none of any sort, however, until the War, when the now famous Richborough and Southampton train ferries

were built. These conveyed engines, heavy machinery, loaded goods wagons, "tanks," and big guns to France, and rendered wonderful service.

The ferry steamers have three or four railway lines to receive the wagons, which are fixed in position while going across. At the ports there is a floating pontoon, so that the railway lines leading to it from the land can rise and fall with the tide to bring the pontoon and the steamer tracks to the same level. The ferry steamer is adapted to fit between piers so that its lines come in the right position, and is fixed while the wagons are being placed on it, or drawn off on the other side.

We give a picture of a fine new ferry boat recently built for the Canadian Government by Sir W. G. Armstrong, Whitworth & Co., Ltd., at a cost of £200,000. She carries twelve Canadian standard railway cars loaded with freight, and makes the nine-mile trip between New Brunswick and Prince Edward Isle in about forty minutes. If there is ice about, however, the journey may be a lengthy affair, so a promenade deck is provided, and there is a dining-saloon, a smoking-room and other comforts usually associated only with long-distance travel.

[*E. N. A.*

ICE-BREAKER LEAVING BAIKAL STATION WITH A SIBERIAN TRAIN ON BOARD.

For many months in the year this lake is frozen over, and the ship has to break her way through the ice.

ROTARY SNOW PLOUGH AT BLUE CAÑON, CALIFORNIA (Southern Pacific Railway).

INTERIOR OF MAIL VAN, LONDON & NORTH WESTERN RAILWAY.

The Tale of a Letter

I AM only a letter; not even a registered letter, or a parcel, but only a plain, humble go-for-twopence letter. But though I am laid aside and my brief life of activity is over, though I am torn and fingered, yet I had one exciting day in my life. In a few short hours I lived through many adventures. I passed through many hands, and had narrow escapes. I travelled many miles and received a warm welcome at the end. Now that I am old and yellow it is a pleasure sometimes to recall that awful time.

I ought to be thankful that I am still alive; many letters are destroyed as soon as they are read. But some, and I am one of them, are kept by careful hands, which often take them out to read. I am getting old, and very yellow; men grow grey, letters grow yellow.

Listen then to my tale, all who read this book, to the tale of a common letter which went for twopence.

Scratch, scratch, scratch! The pen had made its last marks on my outer skin. Before the writer fastened me up he put in a narrow piece of coloured paper and smiled, and I think he said, "That's the kind

of thing to make a letter go down." It was what he called a postal order, and I believe it meant money. After this he pressed the blotting-pad upon me, rang the bell, and gave me to a servant, who at once carried me to the post office round the corner.

That servant was very rough, and I feel the effect of her treatment even now. Of course she put a stamp on me, but she fastened it with a fearful thump which made the post-mistress almost faint, and then for a time I became unconscious and knew no more till I found myself in a big bag with many other letters, hastening to catch the night-mail from a great London station. Ever so many carts were going the same way.

Now a train's a train, and a post office is a post office, but, strange to say, a train is sometimes a post office as well—a sort of travelling post office. They call it the T.P.O. (when you want your friends to turn over the page you say P.T.O.; this is not the same thing quite). Now when you do a little head-work, you see that if a train were not a T.P.O. letters would never arrive in time. It saves hours and hours when letters are arranged and sorted on the train.

[*F. E. Mackay.*

MAIL-BAG READY TO BE PICKED UP BY TRAIN AS IT PASSES.

Soon we came to the big station; and at first we thought things would never get straight. Trucks were everywhere! But everybody seemed to know what to do; there was no confusion. Swiftly the bags were all carried to the vans. The throbbing engine waited for the signal; and when the hour struck we—that is the engine-driver, stoker, passengers, four hundred and more sacks, and I in one of them—steamed out on our long journey.

In the carriages of the T.P.O. there were some very busy men. They had nothing to do with the train but only with the letters, and

[*F. E. Mackay.*
NET ON MAIL VAN, READY TO RECEIVE MAIL-BAG FROM APPARATUS.

they had two carriages to themselves. There were pigeon-holes on one side and rows of pegs on the other, upon which sacks were hung, each with the name of its own district. These men had to see that all the letters for one place were together in one sack. "Sorting" they called it. I could see all this, because I was dropped and forgotten for a short time. It was rather jolly, and it makes this tale frightfully interesting.

I looked at the sacks, and I said, "What a lot of stops we shall have! Every one of these must be set down; we shall crawl very slowly." I didn't know much, but I soon learned. The train could let the sacks go without stopping. This is how the trick was done. It is rather clever, but you should be in it to understand it thoroughly.

There are two things to be done. Sacks and letters have to be picked up, and others have to be set down, and the train mustn't stop. That's the idea. Now how is it done? Listen!

On one side of the carriage is a large net, closed on all sides except that which faces the engine, and projecting two or three feet from the car. On the side of the railway there are high standards on which letter bags are suspended. Just before these standards are reached the man in charge gets the nets out, sets a bell ringing to frighten everybody, and then suddenly, with a frightful smash, the bags

[*F. E. Mackay.*
THE MAIL-BAG HAS JUST BEEN CAUGHT UP AND IS BEING TAKEN INTO THE VAN.

are loosened from the high standards, and come with a crash into the carriage.

More sorting to be done; a pile of letters have been added. But what of the bags to be dropped? This was done at the same moment, so that there was an exchange—some bags were taken in, and others shot out. At the two bottom corners of the doorway in the carriage are two iron standards, about two feet long, and turning on a pivot. When the mail bag is fastened to the upper end it makes the standard horizontal; and so the sacks hang till they are met by the receiving net alongside the line, which waits for them, and out they go—bump, as the others enter—bump.

It must be very dangerous if you are in the way. But the bell goes without ceasing, and everybody keeps away till the bell stops.

The man in charge is awfully clever. He knows exactly where he is, and exactly when to fix the bags that have to go, and to make ready the net; if he lowered it too soon he might smash a bridge or do something dreadful. The carriages are well padded, so that if the sorters roll a bit they get no hurt.

At last one of them saw me. "Here's a letter for ——," he cried. "Just in time," said his mate, "Stick him in there." They put me in a bag just as it was going to be lowered.

The train was going fifty miles an hour; that is, boys and girls, I and the other letters went fifty miles an hour into the net that caught us. Fancy that! Can you wonder that I became unconscious?

When I came to, I heard only the cheerful sounds of the village postman singing his songs as he walked from house to house. At last he came to a full stop, and, putting his hand into the bag, pulled me out, and made me go through the letter-box. The maid put me on the breakfast table. She rather hoped I might be for her, but I was not.

The father of the family looked at me when he came down, but I wasn't for him. Nor was I for the mother and the old folks generally. I was really for little Bob, aged eight, and I came from his uncle, and I had with me a postal-order for five shillings!

It was worth the long journey to see Bob's face. But just to think that I was one evening before in London, and now in the quiet country. It was a very cheap journey, too; it cost 2*d*. Once, in happier times, it used, I am told, to cost only 1*d*.

Yes, I am now living a quiet life. No one to look at me would think that I had been through so much.

A 4-6 0 EXPRESS GOODS LOCOMOTIVE, LONDON & SOUTH WESTERN RAILWAY.

Goods and Mineral Locomotives

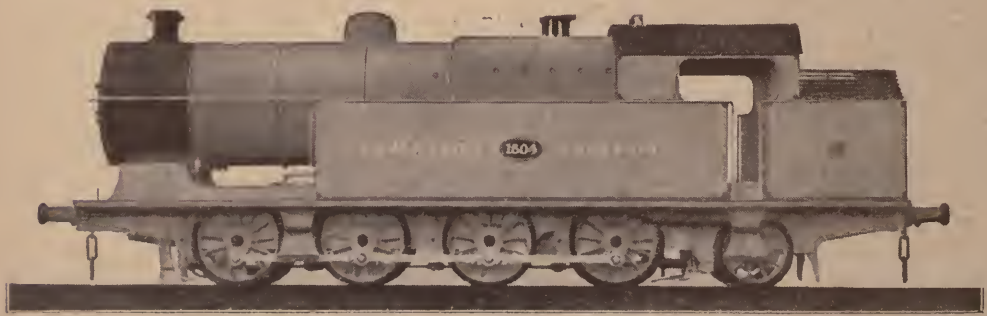
MANY people have the idea that express and passenger traffic is the most valuable, and so it is on some lines. But on most railways the goods and mineral engines earn far more than do the passenger locomotives, and frequently there are many more of them. In fact, the ordinary goods train, jogging along at about fifteen or twenty miles an hour, shunting here and there in sidings and goods yards, or placed on one side to let an express train pass, has frequently a much greater paying load contained in its sixty, seventy or more wagons of various kinds. And as for the long and heavy coal train of dirty, grimy wagons, many having the names of collieries or firms instead of the familiar railway initials, these, if there are many of them, as on the great coal lines, earn many millions of revenue for companies every year.

For conveying one ton of goods the charge is very low, and a ton of coal is brought from Durham to London for about twenty shillings. But as each wagon will take several tons—three or four for goods, eight or ten, or more, for coal—there is usually a big load of goods or coal in a complete train, and as there are so many of these trains, together they earn much more than the passenger trains, except on certain lines where there is not much goods and coal traffic. Therefore the very ordinary and usually dirty engines which pull these trains are very important, though they may not have so much interest.

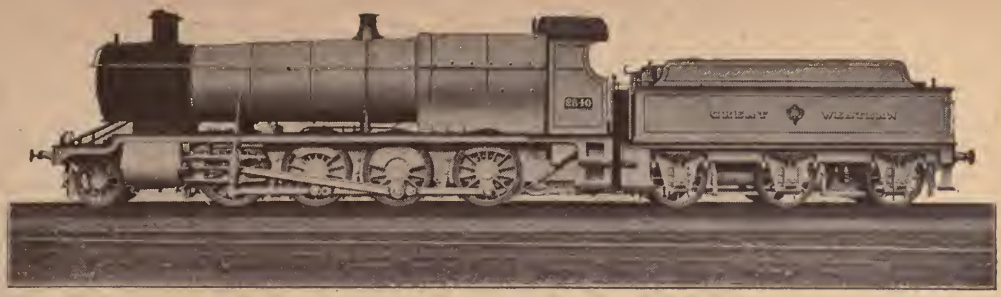
The ordinary goods engines have six wheels and these are all coupled. Examples can be seen on every railway, and although some are really big engines, there is not much of special interest about

A MINERAL TANK ENGINE, GREAT WESTERN RAILWAY.

A 4–8–4 NARROW-GAUGE TANK ENGINE, LONDONDERRY & LOUGH SWILLY RAILWAY.



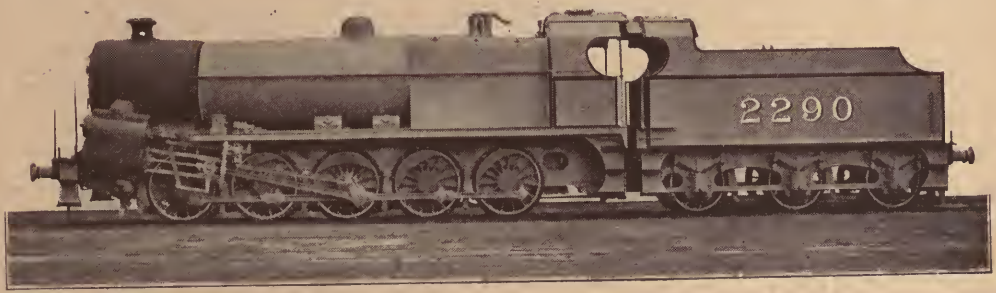
AN EIGHT-COUPLED TANK ENGINE FOR HEAVY COAL SHUNTING, LANCASHIRE & YORKSHIRE RAILWAY.



AN EIGHT-COUPLED MINERAL LOCOMOTIVE, GREAT WESTERN RAILWAY.

A 2–8–0 THREE-CYLINDER MINERAL LOCOMOTIVE, GREAT NORTHERN RAILWAY.

AN EIGHT-COUPLED MINERAL LOCOMOTIVE, LONDON & NORTH WESTERN RAILWAY.



A TEN-COUPLED FOUR-CYLINDER LOCOMOTIVE, USED FOR HELPING TRAINS UP HEAVY INCLINES ON THE BIRMINGHAM-GLOUCESTER SECTION (MIDLAND RAILWAY).

them. But several railways, especially the great coal lines such as the Great Western, London and North Western, Midland, North Eastern, Lancashire and Yorkshire, Great Central and Great Northern, require much bigger engines for their coal trains.

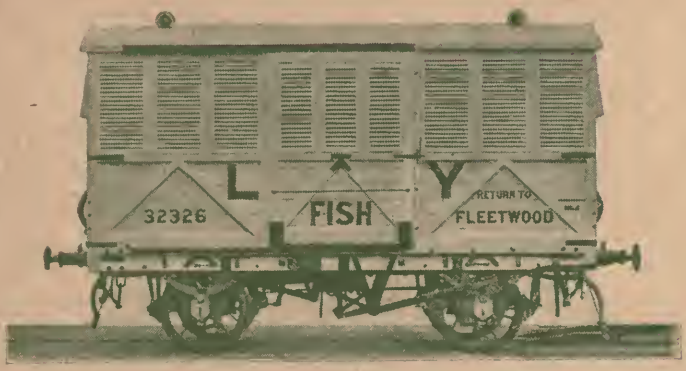
On several lines there are big 2–6–0 engines, with small coupled wheels intended for heavy goods and coal traffic. These are found on the Great Western, London, Brighton and South Coast, South Eastern and Chatham, Caledonian, Glasgow and South Western, and a few

[Fleet Agency.

A GIGANTIC GOODS TRAIN OF FIFTY-FOUR VANS DRAWN BY ONE ENGINE, CHICAGO & NORTH WEST RAILWAY.

other lines, and in Ireland on the Great Southern and Western. The last mentioned railway also has some small-wheeled 4–6–0's for the same traffic, and the Caledonian uses some of similar construction.

But the heavy goods and coal engines are now nearly always 8-coupled. On the London and North Western and Lancashire and Yorkshire Railways there are big 0–8–0 engines fitted with superheaters, and able to pull sixty or seventy loaded coal wagons from the collieries to the ports or big towns. The North Eastern, Hull and



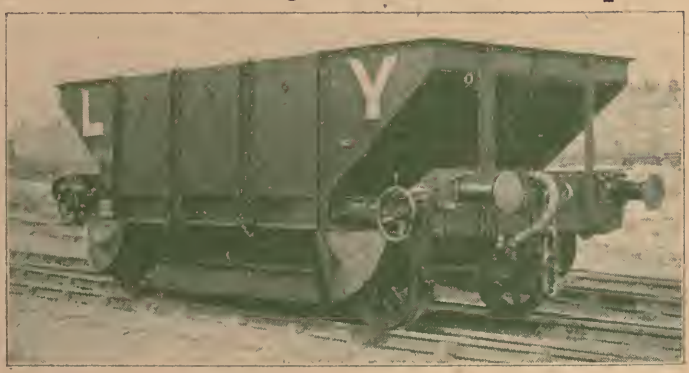
A FISH VAN, LANCASHIRE & YORKSHIRE RAILWAY.

Barnsley, Caledonian, and a few other lines also have engines of this class.

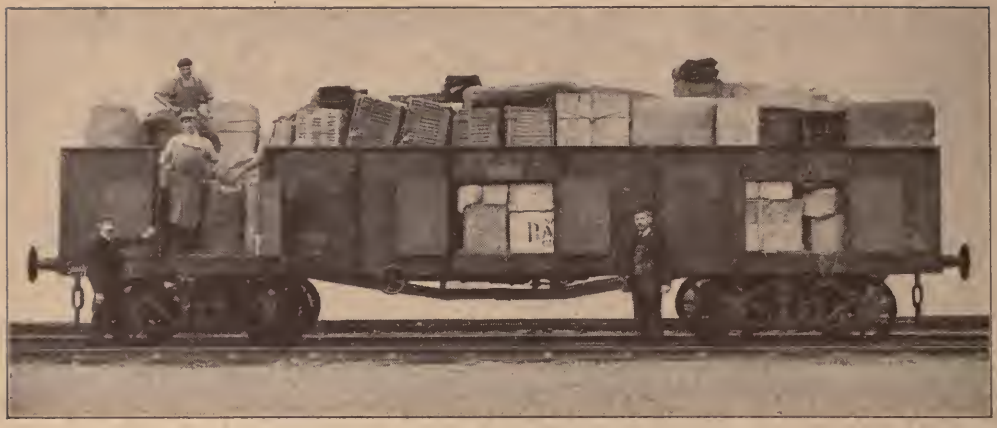
On the Great Western Railway the corresponding engines are 2–8–0, and these can bring enormous loads from South Wales and other parts. The 2–8–0 or "Consolidation" type is, in fact, now the most usual class, for these engines can haul a heavy load at a very good speed. A large number of engines of this design were built specially by various firms for use in France during the War. In fact, while the Great Central Railway had many 2–8–0 engines a little smaller, these new war engines were built before they had any themselves, though the drawings were based upon those prepared for use on their line.

In France such engines often pulled passenger trains, but in England they work only goods and coal. Many of these engines intended for use in France (some since returned, and others which never went over as the War came to an end) are now being used by the London and North Western, Great Western and other railways, though they are rather too heavy for some of our lines, and cannot therefore be used on every railway. Some of these engines are illustrated on p. 159.

The Great Northern Railway has a large number of 2–8–0 engines, and No. 461, which has three cylinders and is specially remarkable in several ways, is illustrated on p. 135. This engine regularly works a load of 1,300 tons up to



A 20-TON COAL TRUCK, LANCASHIRE & YORKSHIRE RAILWAY.
This truck is fitted with doors underneath, so that the contents can be dropped through to coal hoppers below.



A 30-TON STEEL GOODS WAGON, CALEDONIAN RAILWAY.

London, a fact that gives some idea of its great pulling power.

Most of the new 2–8–0 engines have superheaters and other modern fittings, quite as much attention being paid to their design and construction as to the "flyers" which work express trains, though they are not painted in the same way.

AN UNUSUAL LOAD.

The carcase of a huge whale being conveyed by rail. It was caught in Table Bay, Cape Colony, and is shown loaded on a South African Government Railway bogie-wagon.

"Tickets, Please!"

THE first railway tickets were of paper, the name of the station, the name of the passenger, and the number of the latter's seat in the train being filled in by the booking-clerk. This long and tiresome system was soon abolished, but to this day when we go to a station to get a ticket we say we are going to the "booking-office." The little strip of printed pasteboard—the familiar card railway ticket—was invented about seventy years ago by Thomas Edmondson, a station-master on the Newcastle and Carlisle Railway. Finding the filling-in of the paper tickets very troublesome and slow work, it occurred to him that tickets might be printed and checked by progressive numbers. The ticket-printing machine, and the dating press into which the clerk slips the ticket before he hands it to you, were the inventions of this clever station-master.

The printing of tickets by machinery has been brought to a wonderful state of perfection. Firstly, there is the machine that cuts large sheets of pasteboard into strips of the required size. The blank cards are then passed through a printing machine, the appearance of which somewhat resembles a penny-in-the-slot sweetmeat machine. The ticket-printer is entirely self-acting, and will continue to print and number cards so long as the supply lasts. If a frayed or crumpled card gets into the machine, however, the mechanism stops of itself, and cannot be restarted until the bad ticket has been removed. These machines can print more than 10,000 tickets an hour. The third process is the counting of the printed tickets. This is accomplished by another automatic machine, which divides the cards into batches of 250, and can add up 20,000 tickets an hour, recording on a dial the total number it has dealt with.

Tickets are numbered consecutively, so that booking-clerks can see at a glance the quantity sold during any period, such as a day, by deducting the number of the first ticket sold from that protruding from the case for withdrawal next. Inside the booking-office a file of tickets for each separate station and class is kept between two pieces of wood joined by a spring. The tickets are placed in these cases or "tubes," as they are called, with the highest number at the top, while the clerk draws the tickets which he issues from the bottom of the case. It should be explained that tickets are numbered from 0000 to 9999, 10,000 of each kind, class, and station constituting what is called a

"series." There is a great variety of tickets, distinguished by different colours as far as possible. For example, there are ordinary first, second, and third-class tickets; also workmen's tickets at reduced fares, and excursion and other cheap tickets. Dogs, horses, cycles, and perambulators require special tickets. It will be seen, therefore, that there must be rows upon rows of ticket-cases inside the booking-office of an important station.

After the departure of each train the clerk enters in a book how many and what kind of tickets he has issued for it; and at the end of the day he makes up another book, which balances all the tickets he has delivered with the cash receipts.

As railway passenger accounts are based on the booking-office figures the sales of tickets are very carefully checked. In the first place, tickets are supplied to the stations from the Accountant's Department only, and the clerks are held responsible for their face value, that is, the fare which is printed on them. When the officials in charge of the booking-offices find that they have nearly exhausted a "series" they send a demand note to the accountant for a fresh supply, stating the number of the last ticket of that "series" which they have in

INTERIOR OF A GREAT WESTERN BOOKING-OFFICE.

DATING TICKETS AS ISSUED.

stock. Every station has a separate account in the stock registers.

Used tickets are sent from the station where they are given up to the audit office at headquarters. Here they are sorted into their proper "series," and the system of numbering at once reveals if any be missing or have been wrongly issued. Consequently, mistakes or irregularities on the part of the booking-clerks cannot easily escape detection. When the monthly audit of the tickets and cash takings has been completed, the pasteboards are defaced and chopped to pieces by a special machine.

The booking-office of an important station is a very busy place. Besides the clerks who actually issue tickets through the pigeon-holes, there are stock-keepers, cashiers, ledger clerks, etc., hard at work. Stores of fresh tickets to replenish the "tubes" are kept in bundles of 250 in drawers or on shelves around the room. To ease the labours of the clerks during the busiest hours of the day, and to save passengers having to wait in a long file at the ticket windows, automatic ticket-issuing machines, into which the traveller puts the fare and receives a

ticket in exchange, are coming into favour, especially for three-halfpenny and two-penny fares, as on the London "Tubes."

At many stations persons are not allowed on the platform unless they can show a ticket to the man at the barrier, who snips the card so that another person shall not pass with the same ticket. Again, during a journey, our tickets are frequently examined and snipped. But the practice of ticket-snipping is not always concerned wholly with the wish to see if we have paid our fare, or in order to prevent dishonest persons from using the same ticket twice. At some stations the peculiar marks impressed on tickets by the examiner's punch enable the Companies to ascertain the route by which we have travelled, and so adjust between themselves the proportion of the through fare to which each may been titled. Sometimes as many as half a dozen Companies may be concerned in the issue of a single through ticket.

Some of the London Underground Railways issue tickets which can be used in several different ways, but the clips and punches which a ticket receives show exactly where the passenger changed trains and which route he went by. At one station a triangle is clipped out, at another a star, and these and similar devices enable the journey for which the ticket was used to be traced exactly. H. G. A.

"HOW IT WORKS."

[*Valentine & Sons, Ltd., Dundee.*

THE FORTH BRIDGE.

Some Wonderful Railway Bridges

LONG before the days of railways, bridge-building was a science that demanded the skill of the world's best engineers, so that with the coming of the iron-road there were not wanting men capable of constructing the mighty viaducts or bridges necessary for the passage of railway trains over the deep valleys or water-courses that lay in the track of the projected lines.

Great Britain, the motherland of railways, is a small country, but the British boy may point with pride to many a fine railway bridge that reflects in its noble proportions and in its general utility the engineering genius of his native land.

First and foremost, there is the famous Forth Bridge, 1½ miles long, across the Forth at Queensferry. Opened in 1890, it is a truly stupendous structure. The weight of steel employed was a little over 54,000 tons and the 6½ millions of rivets used weighed 4,000 tons. There is a clear headway of 150 feet under the bridge at high spring tides.

Students of the history of Queen Victoria's days are aware of the dreadful train disaster that took place in 1879 when the original bridge over the River Tay was destroyed in a storm. The present Tay Bridge, opened in 1887, is over two miles in length; the structure is of the lattice-girder type and it has eighty-seven spans, the widest,

THE OLD TAY BRIDGE.
Destroyed during a storm in 1879.

over the channel of the river, being 245 feet each, and giving a clear headway of 77 feet above high-water mark.

Scotland possesses also a splendid example of railway viaduct building in the Findhorn Viaduct, of nine spans of 132 feet each, over which passes the Highland Railway.

Bridges built with movable spans in order to allow shipping to pass up and down stream, present in operation a fascinating sight. Such a bridge is that on the Caledonian Railway at Alloa.

Then there are bridges, built on what is called the rolling-lift principle, where a span is raised by machinery in order to permit the passing of a vessel that would not otherwise be able to proceed further. The first of these bridges to be erected in Great Britain was that carrying the railway across the River Swale, in Kent.

Every one has heard of the Britannia Bridge over the Menai Straits, connecting the Welsh mainland with the Isle of Anglesey. It consists

THE NEW TAY BRIDGE.
This bridge is over two miles in length, and consists of 87 spans, eleven of which are 245 feet in extent.

of tubular girders, and when it was built was considered marvellous.

Other famous British bridges include that at Saltash, connecting Devonshire with Cornwall, the Runcorn Bridge over the River Mersey, and the fine King Edward VII Bridge over the Tyne at Newcastle.

In Ireland, pride of place must be given to the Boyne Viaduct at Drogheda, a magnificent structure.

Continental countries, Switzerland for instance, provide fine examples, while British colonies are well to the fore in railway bridge-building. A few examples are the Victoria Bridge and the long Quebec

ALLOA SWING BRIDGE.
The two central spans swing round to allow shipping a free passage.

Bridge across the St. Lawrence River at Montreal, and the trestle structure at Lethbridge, Alberta, on the Canadian Pacific Railway.

Australia has the Hawkesbury River Bridge in New South Wales, a fine specimen of the lattice type, while in Queensland there is an excellent concrete bridge of unusual type on the main line.

In Africa the Zambesi bridge is an easy first, and the Kikuyu Viaduct in Uganda takes some beating as an engineering triumph in an out-of-the-way part of the world.

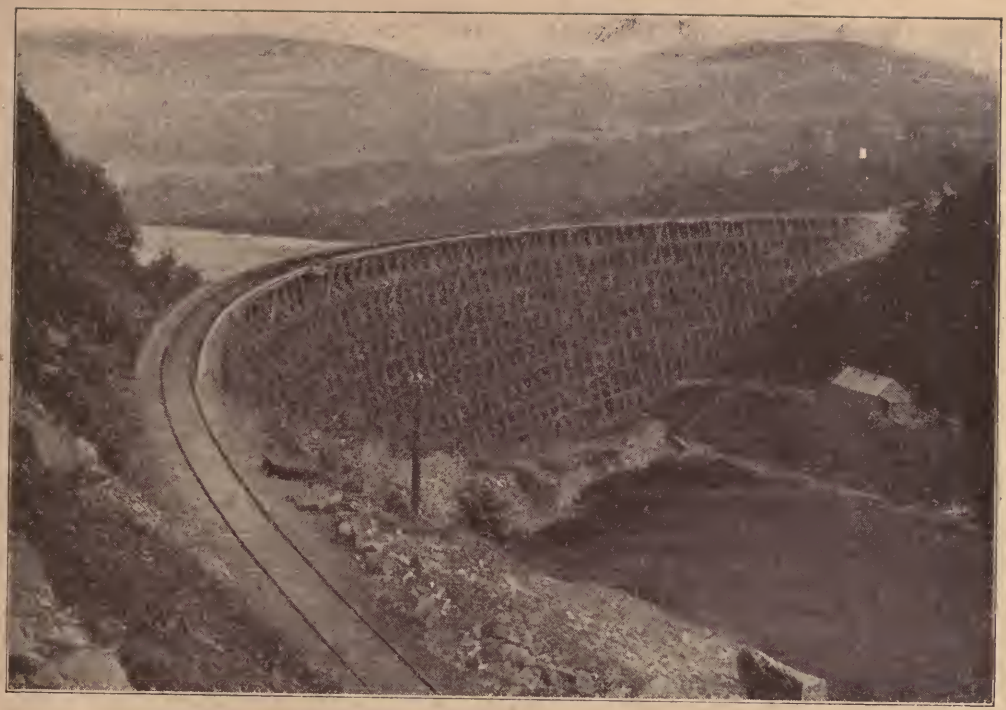
America possesses a railway bridge three and a half miles long, with a huge central arch that is the largest in the world. This is the

BRIDGE OVER THE GREAT SALT LAKE, UTAH, U.S.A.
The train crossing is the "Overland Limited."

recently constructed bridge—perhaps it ought to be called succession of bridges—across the Plains of Bronx, the waters of the Bronx Kills, and the East River and Long Island Marshes. As though its appearance were not sufficiently impressive it bears the title—Hell Gate Bridge.

Railway bridge building, however, has not yet reached its limits, and there is plenty of scope for the skill and ingenuity of the rising race of civil engineers. W. P.

CONCRETE RAILWAY VIADUCT, QUEENSLAND.



RED SUCKER TRESTLE BRIDGE, LAKE SUPERIOR, CANADIAN PACIFIC RAILWAY. [*E. N. A.*

BUILDING THE STEEL BRIDGE OVER THE MCLEOD RIVER, GRAND TRUNK RAILWAY. [*E. N. A.*

[E. N. A

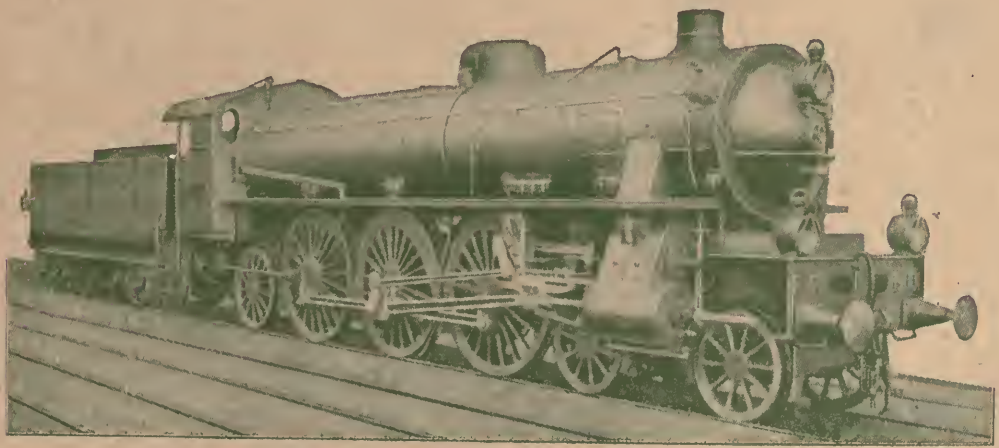
STEAM AND ICE.

A "shivery" photograph taken in the early morning showing a train passing through the ice-gripped country on its way to Pontresina, a favourite Swiss winter sports resort.

A PACIFIC TYPE LOCOMOTIVE, BALTIMORE AND OHIO RAILROAD.

Locomotives of all Countries

A LOCOMOTIVE is substantially the same whether it is designed and built in England, America, France, Italy, or any other country; but during the long years in which each country has been building its own locomotives and making its own railways, many things have tended to make the engines of each nation distinctive. Thus, not only can we say that one engine is British and another American, but we can also identify French, Italian, Swiss, Belgian and many others by a glance at a photograph. Other articles in this



AN ITALIAN 4–6–2 FOUR-CYLINDER EXPRESS LOCOMOTIVE.

book describe interesting locomotives of the British Empire and of the United States, so that we will here deal chiefly with those of the Continent and South America.

French engines always seem to the Britisher to have such a lot of mechanism about them. Although there are six or seven great railways in France, we can nearly always pick out a French engine by its general appearance. On the main routes the expresses are heavy, and before the War were very fast indeed. For these trains the engines chiefly employed were big "Pacifics"; two belonging to the Paris, Lyons and Mediterranean Railway are illustrated on pp. 153 and 155.

[E. N. A.

A LOGGING RAILWAY, BRITISH COLUMBIA.

Belgian engines used to be very ugly indeed, with strange square funnels and queer boilers, but nowadays they are not unlike our own. But the Belgians have some very big engines, and a 4–6–2, in which the leading part projects quite a long way in front of the boiler, is illustrated.

Germany includes several countries, Prussia, Bavaria, Baden, and others, each with its own engines. In Prussia 4–6–0's of great size are the largest, but Baden and Bavaria both have 4–6–2's of notable design. Many of these engines had to be surrendered to the Allies, and are now working French and Belgian trains.

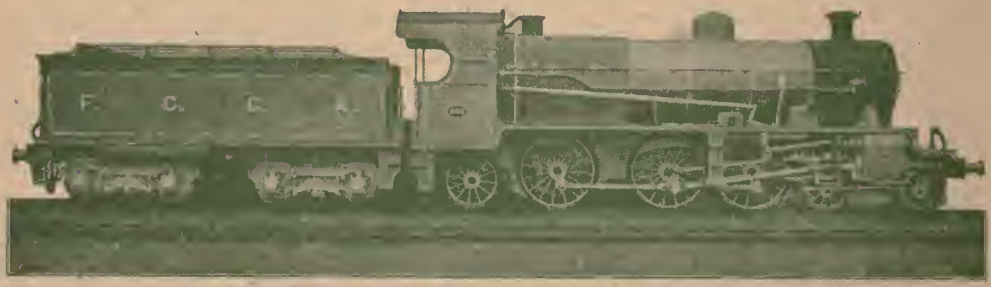
A TEN-COUPLED MINERAL LOCOMOTIVE, SWEDISH STATE RAILWAYS.

Switzerland has no engines larger than 4–6–0, and they are not so very big. In Holland, Denmark, Norway and Sweden, 4–6–0 engines are sufficient for the express passenger trains. For goods, however, some of these countries have big 10-coupled engines; one of these belonging to Sweden is illustrated.

Italy has several interesting locomotive classes, including some which have the driver's cab in front and attach the tender behind the chimney. There are also many of the 2–6–2 or "Prairie" type. But the latest express engines are 4–6–2's and one of these is illustrated on p. 149.

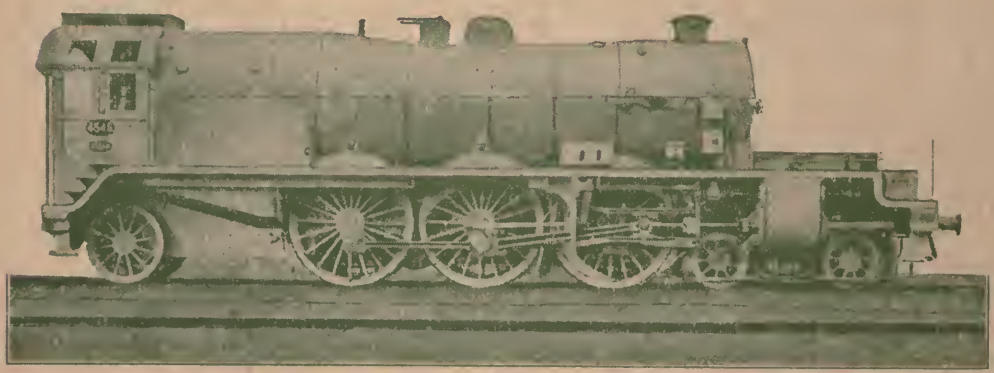
DUBLIN-BELFAST EXPRESS, GREAT NORTHERN RAILWAY (IRELAND).

Spain and Portugal have some big engines, of various types, mostly built in Germany or France, including a 4–8–2 class. In Russia, Austria, and other countries, it is usually the many special



A 4–6–2 LOCOMOTIVE, CENTRAL ARGENTINE RAILWAY.

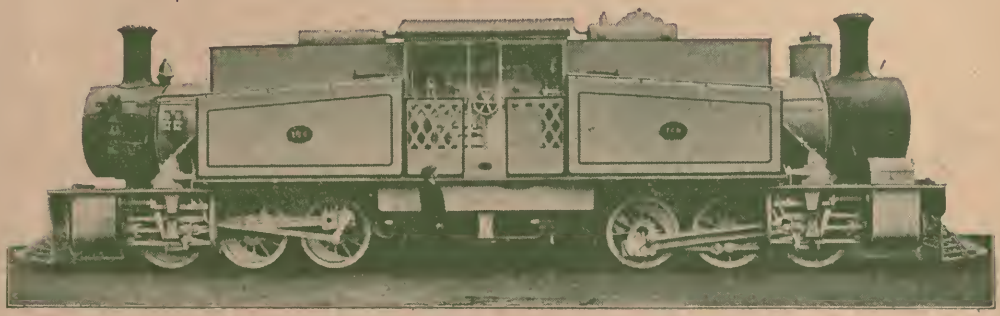
A RUSSIAN 2–8–0 LOCOMOTIVE.



A STRANGE BELGIAN 4–6–2 EXPRESS LOCOMOTIVE.

engines that are of particular interest. For use in the mountains there are 8-coupled and 10-coupled engines, but it will be sufficient to illustrate a strange-looking 2–8–0 Russian engine.

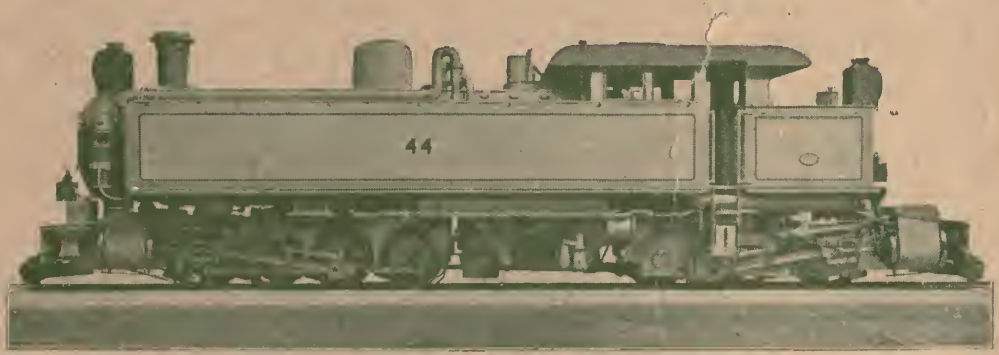
Egypt has engines from all countries, English, American, German, French and Belgian, and these include many interesting classes. The most notable are the big 4–6–0's which work the expresses between



A "FAIRLIE" ENGINE USED ON THE MEXICAN RAILWAYS.

These are practically double engines, with two boilers and two sets of six-coupled wheels. They are useful on sharp curves.

A 4–6–2 EXPRESS LOCOMOTIVE, PARIS, LYONS & MEDITERRANEAN RAILWAY.



COMBINED RACK AND ADHESION LOCOMOTIVE, ARGENTINE TRANSANDINE RAILWAY.

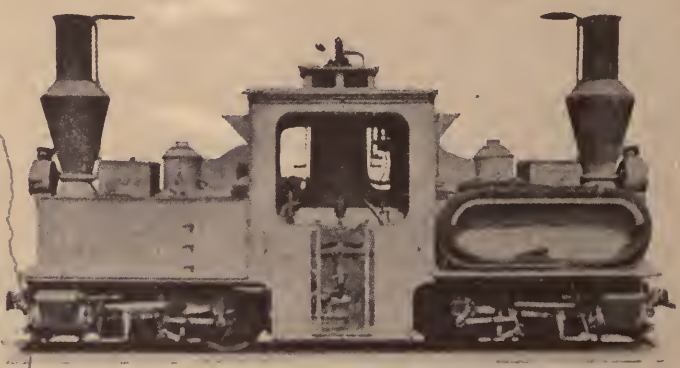
Cairo and Alexandria and on other routes. In North Africa the engines are mainly French, while in Arabia and Persia, as far as there are railways, the engines are largely German in style.

[*W. Stewart.*

4–6–2 ENGINE ON HEAVY PASSENGER TRAIN LEAVING AUCKLAND, NEW ZEALAND GOVERNMENT RAILWAYS.

China has now many railways and most of these have English engines not unlike those used at home. In Japan they chiefly build their own engines or get them from America, but there is nothing special about most of them.

When we come to South America, we find a large proportion of the engines quite British in type. Many are bigger than any of our own, though built in England or Scotland. This is due to the fact that so many of the South American railways are owned by companies in England, and most of their chief officers are English. But in the Argentine Republic there are big 4–6–2 express engines, and in other parts 4–6–0 and 2–8–0 locomotives of interesting design are to be found. There are also the special lines, such as the Antofagasta and Bolivia, and the Transandine Railways across the Andes Mountains, where a rack is laid between the running rails so that by means of toothed wheels the engines can work themselves along and so get up very steep gradients. There are many rack railways in various parts of the world, but those used in South America have the most remarkable engines.



PECHOT TYPE LOCOMOTIVE.

Some hundreds of locomotives of this strange-looking type were built for War work for the French Government. They are similar in principle to the "Fairlie" engines, having two boilers and two separate sets of wheels. They are used on narrow-gauge lines (either temporary or permanent) having sharp and frequent curves.

[*W. H. C. Kelland.*

A 4–6–2 EXPRESS LOCOMOTIVE, WESTERN STATE RAILWAYS, FRANCE.

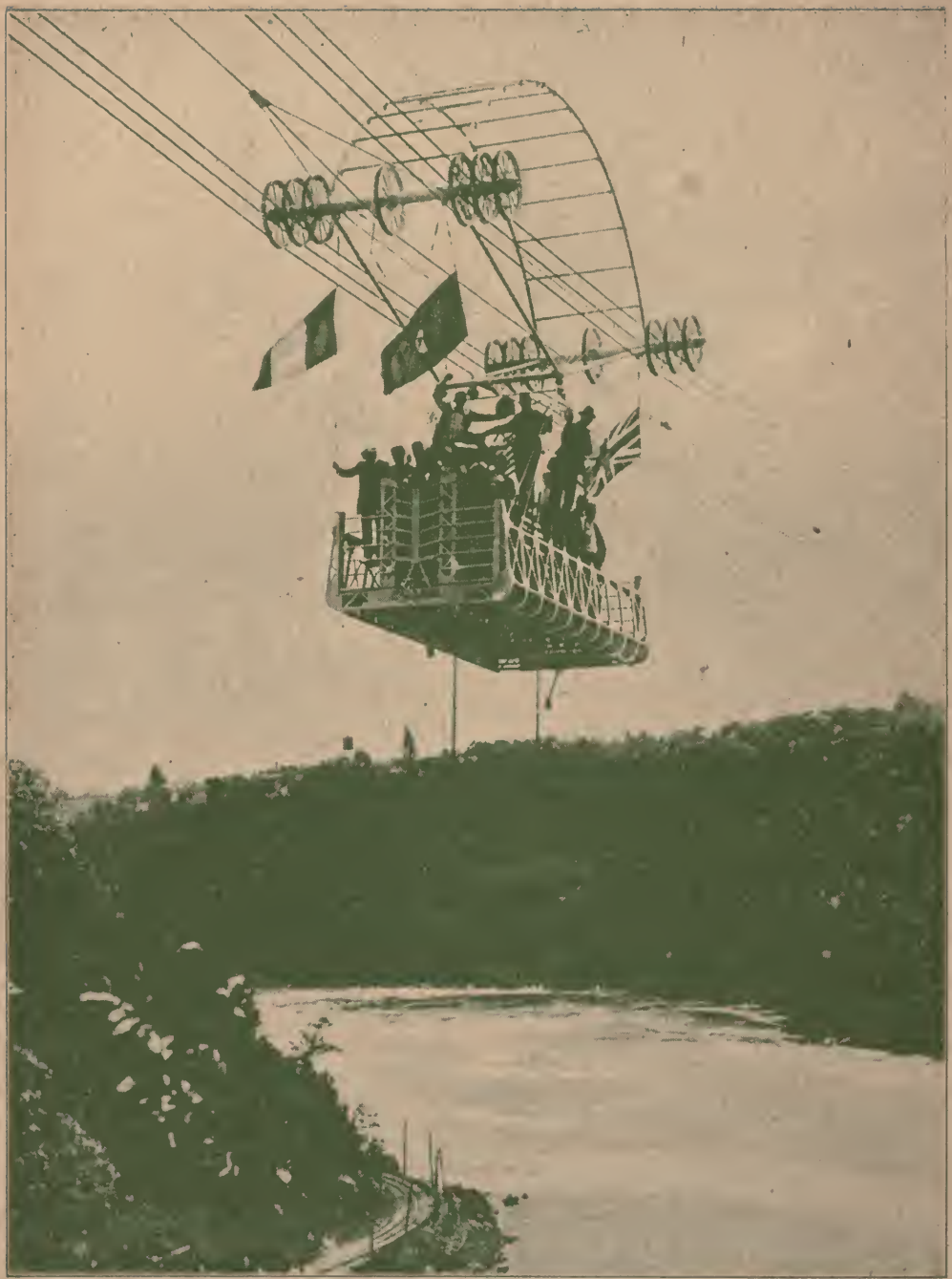
These powerful engines are compound, with four cylinders, and can take big loads at good speed.

[*W. H. C. Kelland.*

A 4–6–2 LOCOMOTIVE, PARIS, LYONS & MEDITERRANEAN RAILWAY, FRANCE.

These engines work the fast "Riviera" expresses from Paris to the South of France and Italy.

TWO FRENCH GIANTS.



[*Underwood & Underwood.*

AERIAL FERRY OVER THE NIAGARA FALLS.

This cableway crosses the famous Niagara whirlpool. The car is run on lines 1,800 feet in length, and is driven by a 75 horse-power electric motor. Thirty-six persons can be accommodated. The car is 150 feet above the water.

WOMEN ENGINE CLEANERS, LANCASHIRE & YORKSHIRE RAILWAY.

Railways in Time of War

IT used to be said that "an army marches on its stomach." In modern times it would be more correct to say that an army depends mainly upon its railways, with steamers where the sea has to be crossed. Motor-lorries, horse vans, barges and small boats are very useful; but railways must do the heavy work on land and steamships the sea transport.

During the Great War thousands of trains were run on the railways of this country to the ports, taking soldiers on their way to France, with all their stores, equipment, guns and ammunition. Thousands of other trains were required to keep them supplied; while even to take new soldiers to camps for training enormous numbers of trains had to be run.

In fact, including journeys "on leave," as well as those "on active service," many millions of soldiers and sailors travelled by train in this country; thousands of carriages were used for nothing else; and tens of thousands of wagons were employed only for carrying ammunition, guns, stores and all the other things an army requires. There were also ambulance trains bringing wounded soldiers to hospitals, and trains run only to take workers in munition factories to and from their work.

Coal was another very big item, and thousands of long trains went from South Wales to the far north of Scotland with coal for the Navy.

[*British Official.*

LAYING A RAILWAY IN MESOPOTAMIA.

In France the railways were so busy that hundreds of miles of new lines had to be made, and miles and miles of sidings laid down. Soldiers travelled as far as possible by rail, frequently in long trains of cattle trucks and goods wagons with three or four engines attached, and some of these trains went right through France to Italy.

Besides the ordinary railways there were some thousands of miles of light railways, on which small locomotives pulled trains of special bogie wagons. These lines often went quite close up to the front trenches, so that the soldiers could be kept well supplied. In fact, these railways were regularly under fire and now and then sections were destroyed or damaged, while hundreds of soldiers working as railwaymen were killed or wounded. It was, indeed, these light railways which involved the most dangerous work.

Small steam engines were used in some places, but as it was dangerous to allow clouds of steam to be seen near the front lines petrol or petrol-electric locomotives were employed there.

There were also even lighter railways, sometimes passing along the trenches, on which small wagons were pushed by men.

In Egypt, Salonika and Mesopotamia many new railways had to be constructed; and in colonies taken from the Germans it was often

necessary to rebuild railways and bridges destroyed before they left.

To work all these railways hundreds of new locomotives and tens of thousands of wagons had to be built. Others were sent across the Channel from Great Britain, and in one way or another France had engines and wagons from almost every part of the world. There were British, French, American, Canadian, Italian, Belgian and some German engines, besides a few intended for Australia and Holland.

Many special trains were in use: for the Commander-in-Chief, travelling workshops, ambulance and hospital trains, bath trains, washing trains, pay trains and every other conceivable kind of train.

In addition, there were armoured trains taking part in the actual fighting, while some of the biggest guns ran on the railways.

For working the railways thousands of men were specially employed as platelayers, bridge builders, engine-drivers, firemen, guards, shunters and so on, while large workshops had to be fitted up for keeping engines and wagons in working order.

Our railways, in fact, did a great deal towards winning the war. They did all that was required at home; they kept the fighting

[Alfieri.

THESE ENGINES WERE BUILT FOR WAR SERVICE, BUT THE LATER ONES WERE NOT REQUIRED. A GROUP IS SHOWN STORED UNTIL THEY COULD BE DISTRIBUTED AMONG THE VARIOUS BRITISH RAILWAYS.

PART OF AMBULANCE TRAIN FOR SERVICE IN FRANCE BUILT BY THE LONDON, BRIGHTON & SOUTH COAST RAILWAY.

armies going; they supplied nearly 200,000 men to the Army and Navy; they sent engines and wagons overseas; and made shells, guns and other things in their workshops on an enormous scale.

A "JELLICOE SPECIAL."

A wartime photograph of a London and North Western Railway coal train ascending the steep incline with supplies for the Grand Fleet. The train is drawn by a four-cylinder compound engine, with an ordinary banking engine behind to get the train over the steep gradient.

THE "SOUTHERN BELLE" (London, Brighton & South Coast Railway).

This luxurious train runs daily in each direction between Victoria and Brighton (51 miles) in 60 minutes. On Sundays it consists entirely of 1st class

[*Alfieri.*

A MOVING STAIRWAY.

The Tube Railways of London

A " TUBE " railway is one in which the trains run in huge metal tubes, or tunnels, generally far under the ground. In London there are now quite a number of railways of this kind, measuring altogether over 40 miles. If we take the length of the tubes used, whether for one line or for two, the total is about 80 miles. All the tubes are of massive steel or iron, large enough for a train, or in some cases for two trains, to run through.

The City and South London Railway, which was opened for traffic so long ago as 1890, was the first " tube " railway in the world.

It was followed by the short Waterloo and City Tube, and in 1900 by the Central London Railway, long known as the " Twopenny Tube " because at first there was only one fare—twopence—no matter how far you travelled.

LOOKING UP A LIFT SHAFT.

This weird-looking picture shows not a tunnel but a shaft. It is, in fact, the lift shaft at Hampstead and you are supposed to be looking *up*. The steel cords which can be seen are those of the counter-balance weights. The shaft is 185 feet deep.

Since then many other Tube lines have been made, most of them belonging to an important company owning the District Railway as well.

The Great Northern and City is the only tube railway through which ordinary railway carriages could pass. When it was first made, the idea was to bring local trains from the Great Northern Railway at Finsbury Park to Moorgate Street over this line, and therefore the tubes were made specially large. But the rails have never been connected at Finsbury Park, and people travelling from one line to the other have to change at that station.

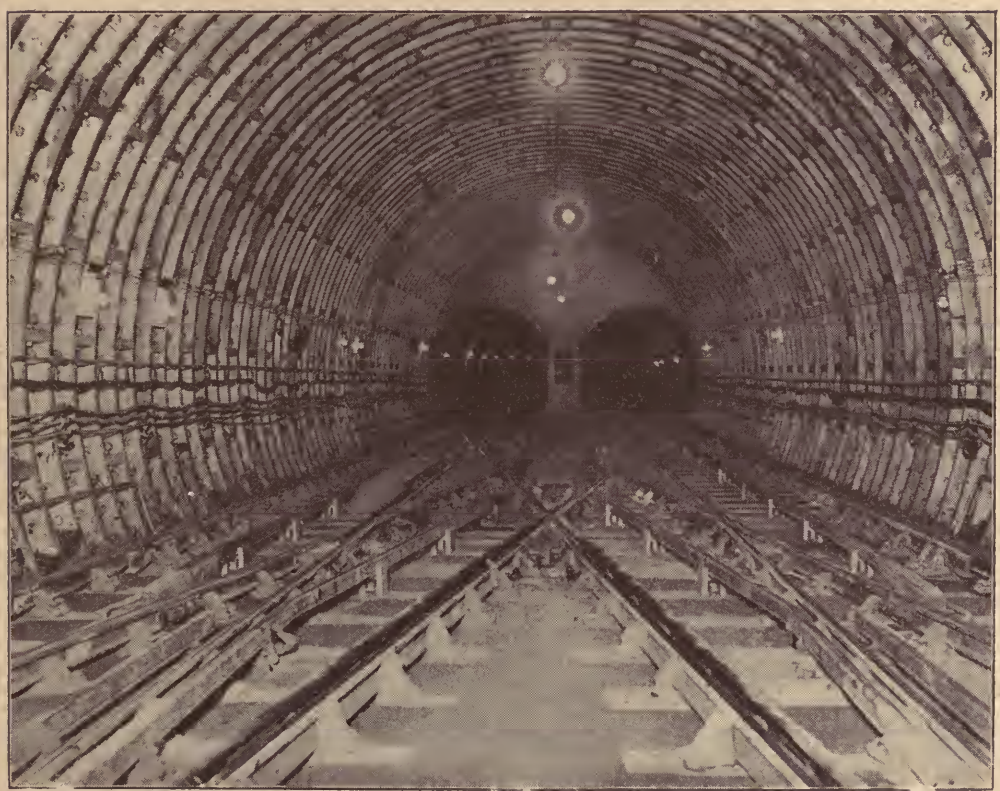
The tube railways are far below ground almost everywhere, much deeper than the ordinary underground railways such as the Metropolitan or the District Railway. They had to be made by special methods, and differ from other railways in many ways.

For making the tunnels shields were employed. These consist of huge frames the same size as the tube to be made, with compartments

for men to work in and for the machinery. As the tunnel is extended this frame is bodily moved forward so that more earth can be dug away, and then the segments of the metal rings that will form the tubes are riveted in place.

Between the stations the tubes are only just large enough to allow a train to pass, but at the stations they are made much larger to contain the platforms as well. In the few places where two lines have to be connected by cross-over points, the tubes are also made specially large to provide room for both tracks.

One of the great disadvantages of railways so deep is that people object to going up or down a hundred or more stairs. Therefore lifts have to be provided, and at nearly every Tube station several of these are continually in use, taking from 20 to 100 people at a time. Some of the lifts go down for more than 100 feet. At several of the most important stations escalators, or "moving stairways," are now pro-



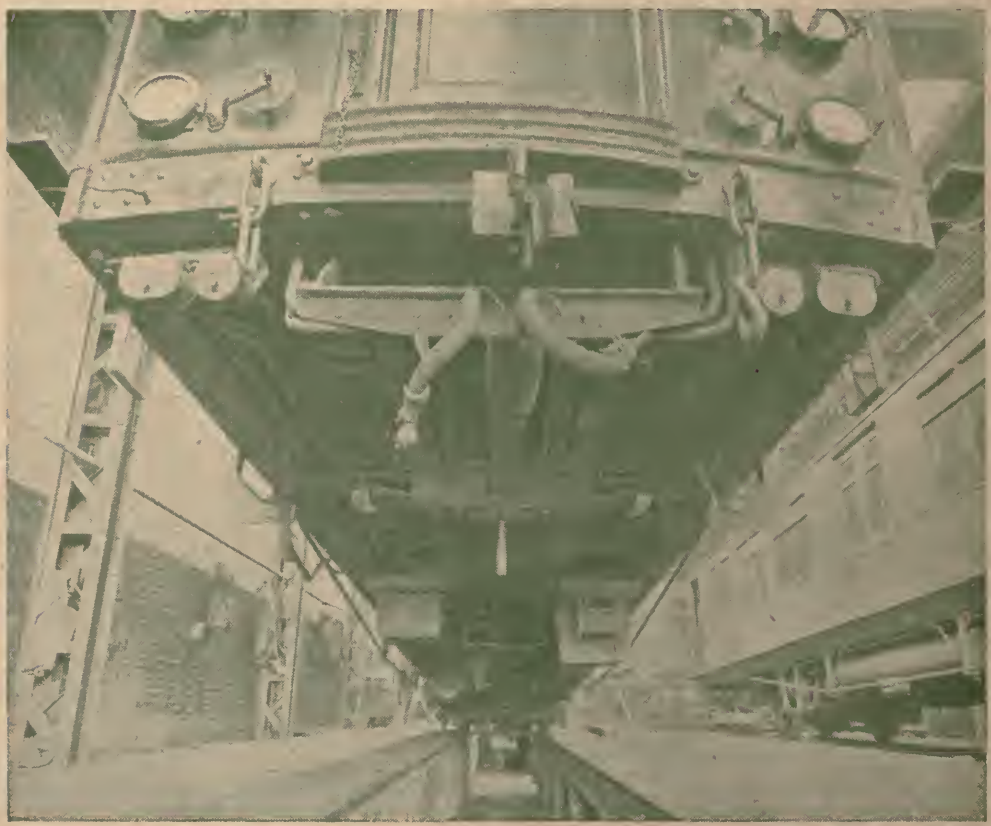
[*Topical.*

CROSS-OVER NEAR LIVERPOOL STREET STATION, CENTRAL LONDON RAILWAY.

Although the greater part of the tube lines are left in darkness, the cross-overs are always lighted.

vided. These are in constant movement, and all that the passenger has to do is to step on and off.

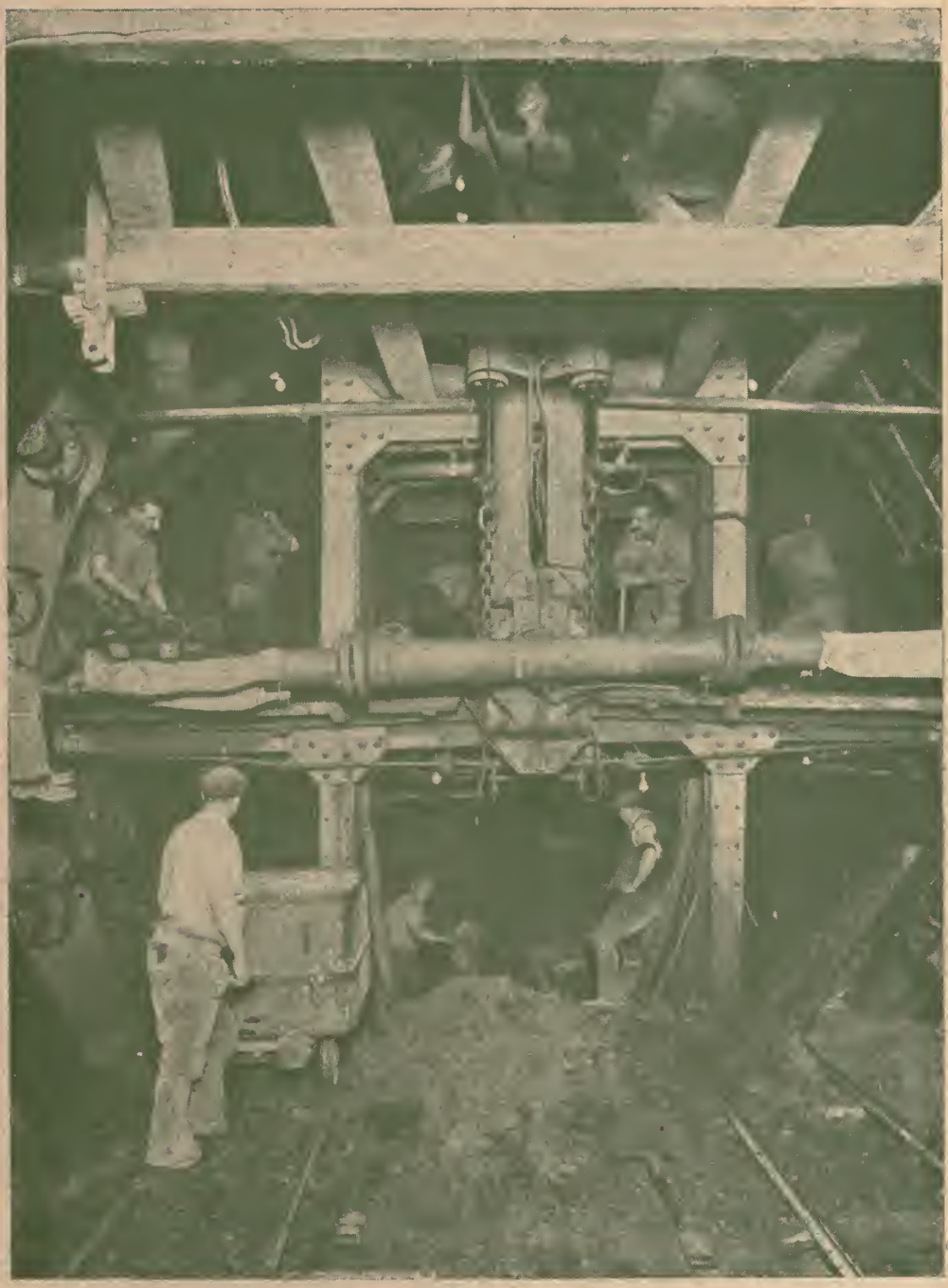
Nearly all the Tube stations are lined with glazed bricks and tiles all over the walls and along the passages between the lifts and the platforms. Many of them, too, have coloured tiles arranged in patterns and at different stations the colours vary. Thus at one station the tiles will be green and white only, at another brown and white, and in



UNDER THE UNDERGROUND: BENEATH A DISTRICT RAILWAY ELECTRIC CAR.

other cases they may be red, green and white. By this means regular passengers get to know the various stations by the colours.

On the Tube railways trains follow one another every few minutes, so that when a passenger reaches the platform he can be sure of a train almost at once, if there is not one already waiting. At the slack hours short trains of two or three cars are sometimes used, but at busy times there may be as many as eight long cars on each train.



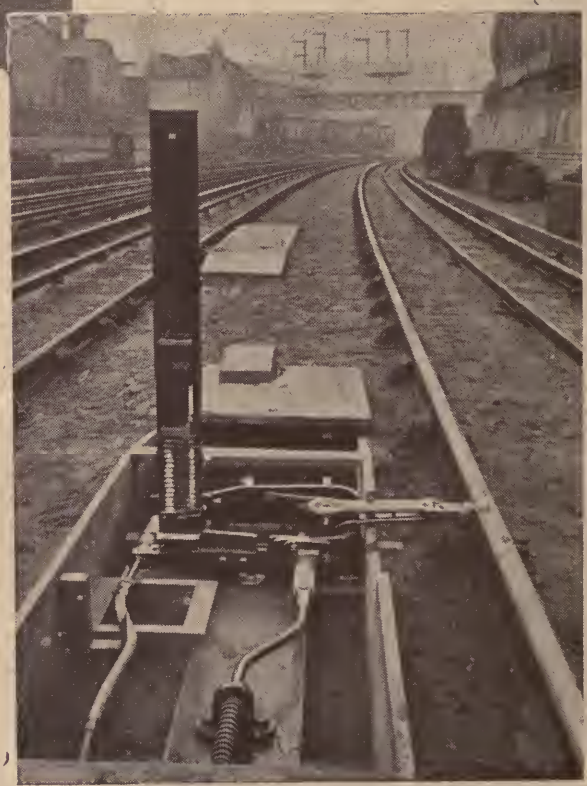
A GREATHEAD SHIELD: EXCAVATING A TUBE TUNNEL.

A HEADWAY CLOCK.

The clock tells the driver exactly how many minutes have passed since the train in front went through. As each train passes the clock the indicating figure goes back to 0.

Only one Tube railway has a junction that is used regularly. On all the others every train makes the same journey, but on the Hampstead Tube there are two routes, one to Highgate, the other to Golder's Green, the junction being at Camden Town. On the Piccadilly Tube there is a junction at Holborn with the Aldwych branch, but this is not used for regular trains. In the usual way a short train runs to and fro all day between Holborn and Aldwych, for the men about the most monotonous piece of railway working imaginable. On the Hampstead and Piccadilly tubes a number of "non-stop" trains are run, but mostly the trains stop at every station.

On the Tube railways the trains run fairly fast, sometimes as much as 35 or 40 miles an hour between stations, and as they are so frequent everything possible has to be done to ensure that they shall not be delayed. Most of these



A MODERN MODE OF FOG-SIGNALLING.

On the open-air sections of the District Railway a clever device is used for fog-signalling. It is operated with the signal and a man is not needed to place the detonator on the line. As each detonator is exploded the apparatus sets a fresh one.

lines have automatic signals, so that the trains signal themselves.

The Piccadilly, Bakerloo and Hampstead Tubes have always worked together, in fact they belong to the same company, and at Leicester Square station there is an office from which the traffic of all three is controlled. Here there are automatic indicators which record the exact time every train on the three railways passes a certain point. There is also a headway clock which can be switched on to show the interval between any two trains at a known position on either railway. And there is a telephone switchboard which enables the traffic controller to speak to any station, or if need be to several stations at the same time.

On some of the railways headway clocks are fitted at the end of the

A TYPICAL TUBE STATION.

platforms in order to inform a driver how many minutes the previous train is ahead of him. As each train leaves, the indicating finger goes back to zero and starts again.

In the course of a year nearly four hundred millions of passengers were conveyed on the Tube railways of London alone, and this will give some idea of the enormous amount of traffic. Many of the stations are connected by subways with the great main-line termini, like Euston, King's Cross, etc., and with other underground stations.

Some of the Tube railways have an official whose duty it is to watch the weather. If rain is coming he sends a message to the car sheds, and extra trains are got ready for the expected rush of passengers.

J. F. G.

A SUBURBAN TRAIN, GREAT EASTERN RAILWAY.

THE CHARLES C. MACRAE.

This fine 4–6–4 Express Tank Engine, weighing almost 100 tons, belongs to the London, Brighton & South Coast Railway.

Passenger Tank Engines

A LOCOMOTIVE which has a separate tender for carrying supplies of coal and water is called in Great Britain a "tender" engine, but in France and some other countries a *machine-tender*, or "tender locomotive," is one which carries the coal and the water tanks on the same frame as the boiler and the working parts of the engine. That is what we know as a "tank" engine.

Naturally, a tank engine cannot carry so much coal and water as a locomotive having a separate tender for the purpose, so such engines are generally used for local trains making short journeys or stopping frequently. But many tank engines are quite large, and can carry enough coal and water to enable them to make fairly long journeys. On many railways they work fast, and even express, trains if the non-stop run is not too long. In fact, they often run 30 or 40 miles without stopping, sometimes even sixty or seventy if they are big enough; while some have coupled wheels as large as those of express tender engines.

In years gone by tank engines were generally quite small, and many are still far from large. Take, for instance, the little six-coupled tank engines with coupled wheels only 4 feet in diameter, to be seen on Enfield and Chingford trains at Liverpool Street, the London terminus of the Great Eastern Railway. Yet they pull 16 four-wheeled coaches, sometimes packed with passengers, up the steep bank to Bethnal

Green, and do it well, while they can travel fairly fast, even up to 45 or 50 miles an hour, though not very often.

But most of the tank engines used for suburban trains have at least 8 wheels. A common type is the 0–4–4, with four coupled wheels in front and a bogie at the bunker end. Another type is the 2–4–2, called a "double-ender," as the wheels are the same either way. These are largely found on the Great Eastern Railway, while the Lancashire and Yorkshire Railway uses hardly any other type of tank engine.

For hard pulling, six-coupled engines of the 0–6–2 type are very useful, and many of them can be seen on various lines. In order that more coal and water can be carried, many tank engines now have a bogie at the back end, so that the type is 0–6–4, as illustrated by the "Lord Aberconway," used by the Metropolitan Railway for working passenger trains between Harrow and Aylesbury.

The 4–4–2 type is, however, the best known of the express tank engine classes, and on some railways they are real express locomotives, with 6 ft. 6 in. coupled wheels, and able to run 40 or 50 miles without a stop as fast as any express engine. Thus, on the London, Brighton and South Coast Railway, big 4–4–2 tank engines run the 60-minute expresses (51 miles) between London and Brighton, and also make non-stop journeys of 66 miles to Eastbourne, and on the Portsmouth line even of 74 miles without a stop. The Great Western and the London, Tilbury and Southend section of the Midland Railway have also some of these express tank engines.

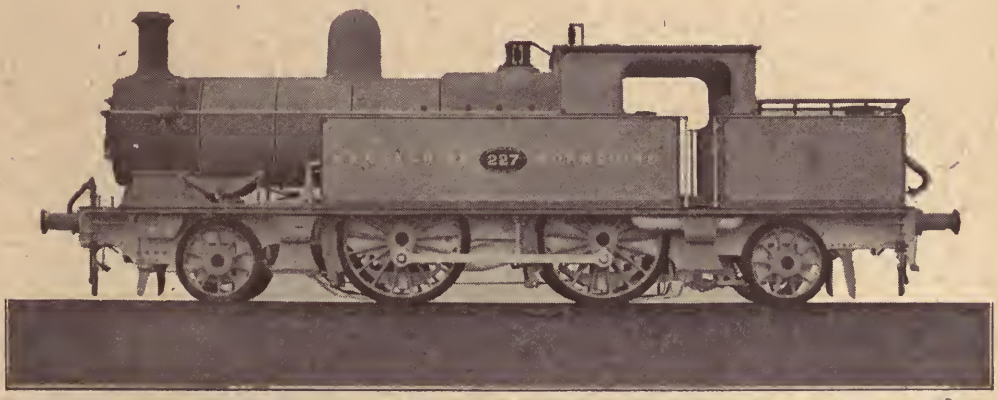
The ordinary 4–4–2 tank engines have coupled wheels about 5 ft. 6 in. diameter, and are therefore more suitable for local trains. On the London and North Western Railway and other lines some of these make long journeys of 70 miles or more, though stopping at many stations on the way. Sometimes they also do some long fast runs, such as between Willesden Junction and Bletchley, on the London and North Western main line, a distance of about 42 miles, with top speeds well over 60 miles an hour.

These 4–4–2 engines are big machines, but several railways have gone in for much larger ones. On the North Eastern Railway there are some 4–4–4 engines with a bogie at each end and four coupled wheels between, and these have three cylinders, like the principal express engines on that line. But, as a rule, if very big tank engines are built they have six coupled wheels, and of these there are several classes.

PASSENGER TANK ENGINES

MAIN LINE TANK ENGINE (2–6–4), SOUTH EASTERN & CHATHAM RAILWAY.

THREE-CYLINDER TANK ENGINE (4–4–4), NORTH EASTERN RAILWAY.



SUPERHEATER TANK ENGINE (2–4–2), LANCASHIRE & YORKSHIRE RAILWAY.

The big 2–6–4 tank engine on the South Eastern and Chatham Railway has a two-wheeled pony-truck in front of the six-coupled wheels and a bogie behind ; this is a very fine engine indeed. It is the only one of its class so far, but it has been used for working trains between London and Folkestone, 70 miles or so, stopping only two or three times, and has done some fast running.

Then there are several classes of 4–6–2 engines, bogie, six-coupled wheels and a trailing pair of wheels under the bunker. Those on the London, Brighton and South Coast Railway, named " Abergavenny " and " Bessborough," are really express engines, with 6 ft. 6 in. coupled wheels, and work express trains. On the Great Central, the London and North Western and the Caledonian Railways the wheels are not so large, so that they are not exactly express engines, but they do some fast work. Those of the Caledonian Railway work some of the Coast expresses from Glasgow, which connect with the wonderful steamer services which ply to and fro in all directions on the Firth of Clyde.

The 2–6–2 type is similar, but with a two-wheeled pony-truck in front instead of a bogie ; it is very common on the Great Western Railway, and there are a few other lines which use it. But the most interesting of the big tank engines are the 4–6–4's, sometimes known as " Baltic's " (this name is English, not American). The biggest of all are the two very large Brighton engines, No. 327, " Charles C. Macrae," and No. 328 (not named). These each weigh almost 100 tons, and have large coupled wheels, so that, like the big-wheeled 4–4–2 and 4–6–2 tank engines of that line, they take a share in the

THE " LORD ABERCONWAY " SUPERHEATER TANK ENGINE (0–6–4), METROPOLITAN RAILWAY.

A 4–4–2 TANK ENGINE, GREAT WESTERN RAILWAY.

fastest and heaviest work of the line. There are also some on the Midland Railway almost as big.

So that while a tank engine is generally thought to be one for working only local trains, even the usual classes often do main line work, and on many railways very big ones have been built, directly intended for working express trains where the journeys are not too long. By carrying coal and water on the same frame as the engine, the cost of a separate tender is avoided, and as it is not necessary to turn the locomotive at the end of each journey, trouble is often saved. Some tank engines can, while travelling, pick up water from troughs between the rails, in the same way as do express engines, while 3 or 4 tons of coal will serve for a fairly long journey. But for really long runs tender locomotives will, of course, be required, however big the tank engines we may yet see on our main railways.

On many railways old tank engines are adapted to run with several coaches to form "motor trains" or "auto-trains." The end compartment of the rear coach is provided with apparatus by which the driver can work the engine, although it is then at the back of the train. Sometimes coaches are attached at each end, with the engine in the middle. These trains run to and fro without altering the position of the engine, the driver being in the "control" compartment when that is in front.

Staff Signals

SIGNALLING on main lines and important branches is described in other articles. But in many parts of the country, where only a few trains are required, it does not pay to make a double-track railway, so both up and down trains have to use the same set of rails.

The working of single-line railways has to be very carefully arranged, for a frightful accident would result if trains travelling in opposite directions collided.

Years ago, and still on less important branches, what is known as the "staff and ticket" system was used, but now most single lines of importance are worked by an electric train staff or tablet. Unless a driver has received this token from the signalman nothing will induce him to steam on. These staffs or tablets, suitably inscribed to show to which section they belong, are kept at either of any two stations, locked in an apparatus which is opened and shut by electricity. The signalman at A holds the key which unlocks the apparatus at B, while B in return has the key to the apparatus at A. Now imagine a train at A ready to start for B, all the staffs being safe in one apparatus or the other. A calls to B through the telegraph, B sends an electric current which unlocks A's apparatus, and A takes out one staff (he cannot withdraw more than one at a time), hands it to the driver, and away the train goes to B. Arrived there, the driver surrenders his staff, and gets in exchange one for the next section, which we may call B C. The signalman at B then places the staff he has just received into his apparatus, and until the staff has been restored to one apparatus or the other, neither signalman can withdraw another staff. For the electric locking is so arranged that it is impossible for more than one tablet or staff belonging to any one section to be out at the same time; thus to get two trains in the

ELECTRIC TRAIN STAFF APPARATUS, LONDON & NORTH WESTERN RAILWAY.

same section at the same time is impossible.

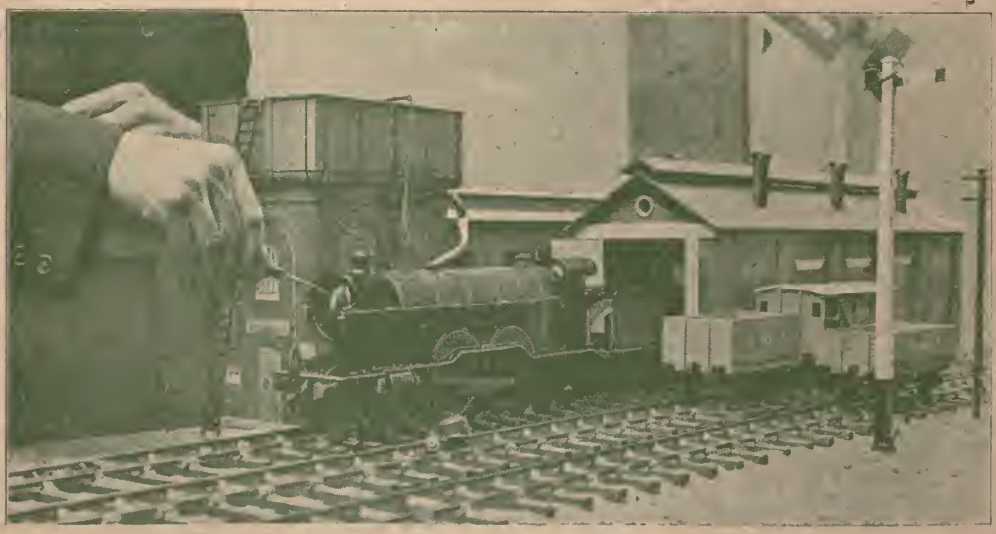
On some single lines, in order to avoid stopping at signal cabins while the staffs or tablets are exchanged, special devices are installed, which enable the operations to be performed while the train is at speed. Our picture shows the act of "staff catching" on a branch of the Great Western Railway. By the side of the line is fixed a post with a socket for holding the staff in a suitable position to be picked up, the staff being furnished with a looped handle so that the engine-driver can grasp it easily. The discarding apparatus is more elaborate. On the top of the post is a leather padded board, from which a curved arm projects towards the train. A driver dropping a staff has to thread the looped handle on to this arm. The object of the leather padding is to absorb the force of the blow, and prevent the staff from bounding off the arm, while, as an additional precaution, in certain places the target is backed by netting, so that if the staff flies off the arm it does not fall into the sea or a ravine. Each kind of post is lit by a lamp whose beams shine on the right place, hence the exchange can be made by night as well as by day. By means of these "catchers" it is only necessary for a train to slacken speed to about 20 miles per hour. On some railways, however, devices are used by which the staffs, or leather cases containing the tablets, can be exchanged mechanically even at speeds of more than 60 miles an hour. An apparatus on the side of the engine meets an apparatus alongside the line, and, while giving up one staff or tablet case, catches another, on very much the same principle as mail-bags are caught up and delivered into nets.

A DRIVER PICKING UP THE STAFF WHILE TRAVELLING AT SPEED, GREAT WESTERN RAILWAY.

4–6–2 LOCOMOTIVE, ESKDALE RAILWAY (15-INCH GAUGE).

The 19.15 Express

IF you were to see this posted up at a railway station you would wonder what it meant. Yet in some other countries this is how they would describe a train due to start at a quarter-past seven in the evening. And before you are many years older it is quite probable that we shall do the same in Great Britain. The day has twenty-four hours, yet our clocks show only twelve and these have to do duty twice over. It is easy to make a mistake between 7.15 in the morning and 7.15 at night. But if we call the second 19.15 everything is quite clear. Only it requires a little getting used to.



"NOTHING LIKE OIL."

THE "OLYMPIAN" CLIMBING THE CONTINENTAL DIVIDE, ROCKY MOUNTAINS, MONTANA.

The World's Longest Electrified Railway

AS in the case of so many big things, one has to go to the United States of America to see the longest electrified railway. The tight little island home of George Stephenson, where the whistle of the steam locomotive was first heard, has not lent itself to the development of electrical transportation to the same degree as other lands with greater water-power.

Two remarkable American achievements are the electrification of the Elkhorn grade of the Norfolk and Western Railway (used mainly for freight traffic) and the Philadelphia-Paoli suburban electrification carried out by the Pennsylvanian Railroad. On many other short stretches of main line in the United States that were formerly operated by steam, trains are now driven by electricity, but these are comparatively unambitious schemes compared with that of the Chicago, Milwaukee and St. Paul Railway, whereby steam engines have been superseded by electric locomotives over the long section of 440 miles from Harlowton, Montana, to Avery, Idaho, the State with the Indian name signifying "gem of the mountains." Including yards and sidings, the electrified trackage totals 650 miles. The Chicago, Milwaukee and St. Paul line is the chief link between the great cities of the Central Lakes region and the North Pacific Coast. It has a total mileage of more than 10,000 miles and serves the people of eighteen States.

A 55-CAR FREIGHT TRAIN OF 1,450 TONS ON THE CHICAGO, MILWAUKEE AND ST. PAUL ELECTRIC RAILWAY.

Montana means "mountainous," and the territory is rightly named. Three mountain ranges are included in the electric zone of this line. The Belt Mountains are crossed at an altitude of 5,788 feet at Summit; the main Rockies, or the Continental Divide, at an altitude of 6,322 feet at Donald; and the Bitter Root Mountains at an altitude of 4,163 feet at East Portal. Pipestone Tunnel, the half-mile bore through the backbone of the North American Continent at Donald, is the highest elevation of the railway. A glance at a profile map of the Cordillera portion of the United States will show the physical difficulties the engineers had to overcome before huge goods trains and heavy all-steel passenger trains could be hauled by electric locomotives over this rocky region. In one part the line climbs 53 feet to the mile.

The electric locomotive, however big it may be, is not so awe-inspiring as a mammoth steam engine, but it commands considerable respect. The locomotives employed on this mountain section of the Chicago, Milwaukee and St. Paul Railway are of enormous power. Each has for its driving equipment eight massive 430 horse-power motors geared to a driving axle, thus giving 3,440 horse-power to each locomotive. Although the locomotive body is divided in the centre for

greater flexibility in handling, the engine is a unit, with four of its motors at each end.

Just as an electric tram-car is controlled from either end at will, so is this locomotive, and—again like a tram-car—it requires no turn-tables. The length of one of these locomotives over all is 112 feet, and the weight 284 tons, more than six tons heavier than the Mallet compound engines (with tender), the mammoth steam locomotives of modern type that are in use on other sections of the Chicago, Milwaukee and St. Paul Railway.

One electric locomotive takes the place of four ordinary steam engines. It is capable of handling its full tonnage on a heavy gradient at 15 to 16 miles an hour, as against 8 to 10 miles an hour for the steam locomotive. On a 1 per cent. gradient it will haul an 800-ton passenger train at 25 miles an hour, or on level track at 60 miles.

Among the many advantages claimed for these electrical mammoths in their work among the mountains, in addition to their hauling power and speed, is that they use neither coal nor water and require no tenders. Each will run 1,000 miles with only slight attention. There are no ashes to dump; no flues to clean; no boilers to inspect.

AMONG THE ROCKY MOUNTAINS.
A train on the Chicago, Milwaukee and St. Paul Electric Railway.

Cold has no influence on the working of an electric locomotive and the greater driving power is of much advantage when snowdrifts are encountered.

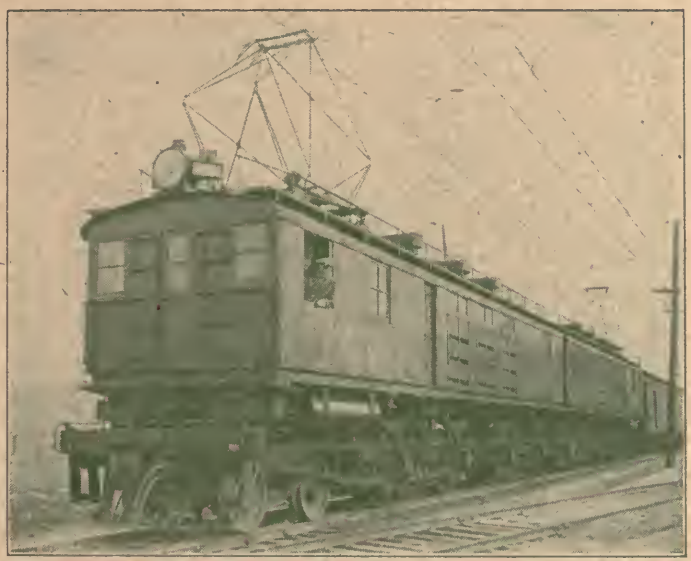
Instead of the simple one-contact trolley of the street tram-car, the electric locomotive takes the current from overhead wires by means of an ingenious double trolley called a "pantagraph," after the draughtsman's enlarging instrument of the same name. The use of this double-contact trolley, travelling on a double trolley wire, ensures perfect contact at all times.

From the pantagraph the electric current passes to the engine-driver's control in the interior of the electric locomotive. The interior itself is a veritable wonderland, with its ammeters, gauges, and speed indicators, its oil-fired steam boiler for heating the train, its compressors for operating the auxiliary air-brakes, and its small, motor-driven dynamos for use in the system of "regenerative braking" employed. It is the necessity for finding room for so much internal machinery, to say nothing of the compartment for the driver and his mate at each end, that makes the electric locomotive of such length.

Whence comes the mighty force necessary to haul these mammoth locomotives and their heavy loads over the mountains? It comes from harnessing the natural water-power of the country to provide electrical energy. The Montana Power Company supplies the railway with current at seven different points between Avery and Harlowton. The power plants are served by natural waterfalls, but to guard against a shortage of water in the dry months of late summer and during the winter months when the usual flow is at a minimum, water is impounded in a storage reservoir covering an area of many miles. By this and a natural reservoir—Flathead Lake—the railway is safeguarded against interrupted service. As a further insurance against accidents each of the Chicago, Milwaukee and St. Paul Railway's electrical substations is fed from two sources of supply.

Here one may pause and reflect upon the natural law of the conservation and correlation of energy. In the Great Falls' water-power there exists millions of foot-pounds of energy. For ages this force did no useful work, until man introduced turbine waterwheels, and compelled the hurrying element to turn them. This produced motion, which, transmitted to dynamos, reappeared in another form—electrical energy. In the coils of the transformers in the substations this 100,000 volt-current "induces" a separate "secondary" current

at 2,300 volts. This current induces motion again in the armatures of the alternating current motors, which in turn drive generators that produce electricity again—this time direct. In the motors of the electric locomotive this current again produces rotary motion, and in the train as a whole horizontal motion. In the incandescent bulbs that illuminate the train the self-same current, or its equivalent, produces light and a modicum of heat. To the uninitiated it may sound somewhat like "This is the house that Jack built," but it is none the less true. At the reduced pressure of 3,000 volts the direct current passes from the substations to the feeder-wires, thence to



A MIGHTY ELECTRIC LOCOMOTIVE.
The "Olympian," hauled by a 3,440 horse-power electric locomotive, about to start on its 440 mile run over the Rocky Mountains.

the trolley-wires, and by pantagraph contact to the engine-driver's control, then through the motors, and through the wheels and rails to earth.

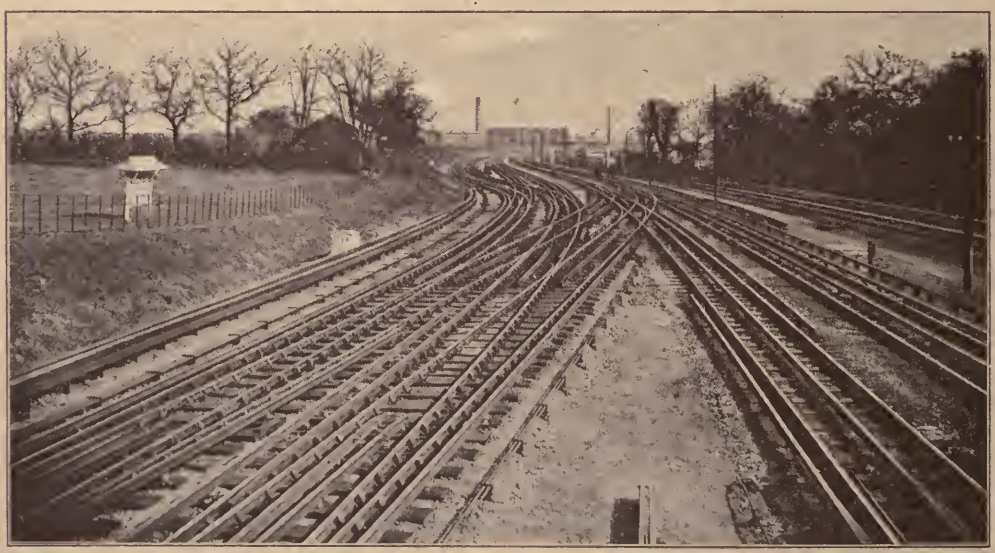
The through passenger service over the mountain division of the Chicago, Milwaukee and St. Paul Railway consists of two finely equipped transcontinental trains, the "Olympian" and the "Columbian," which run daily in each direction, from Chicago and from Tacoma and Seattle. Forty new trains were placed on the electrified section at its inauguration to maintain the various services.

Very fine trains are these and their owners are justly proud of

them. "All-steel," elegantly furnished, and fitted with every luxury for a transcontinental railway journey—including even facilities for hot and cold baths—they claim to be "the last word for business and pleasure travelling." In any case a trip of 440 miles over the Belts, Rockies, and Bitter Roots, the three mountain ranges which form the great Continental Divide, is of entrancing enjoyment, but when made in the security and comfort of one of these famous trains, hauled by one of the largest and most powerful electric locomotives ever built, the most exacting traveller has an experience he is never likely to forget.

It is hardly too much to say, in the language of the managers of the line, "The electrification of the 440 miles of main line over the Great Continental Divide is a long stride forward in railroading, in electricity and in the conservation of resources. To produce enormous power from mountain waterfalls instead of from coal, to transmit this power in the form of electricity over great distances with but small loss in transmission, and to apply it so as to promote more efficient and economical operation, is an achievement of the Chicago, Milwaukee and St. Paul Railway which has created a new epoch in railroad transportation and erected another milestone in the world's progress."

W. P.



SOME COMPLICATED ELECTRIC LINES, NEAR WEMBLEY PARK, METROPOLITAN RAILWAY.

RACE TRAINS IN DONCASTER WORKS YARD DURING ST. LEGER WEEK

Drudges of the Line

TO-AND-FRO all day long, first pulling a few wagons, then pushing them back, or sending them flying in twos or threes on another line, and so "making up" or "breaking up" trains of goods or coal wagons in the yards and sidings. Or perhaps taking a local goods train to the docks, doing shunting at one local station, then proceeding to the next, and so on, possibly spending three or four hours in covering a journey of a dozen miles.

Not a very exciting life, though most boys like to see the trucks go flying from the engine as it gives them a vigorous push off and then stops sharply itself; but the little engines which spend their days in this manner are very important and useful. They are, in truth, "drudges" of the line, but we could not get on without them; and drivers and shunters must thoroughly understand one another and what is wanted, else, instead of being helpful, they will only make what appears to be a jumble of wagons into a serious muddle.

As a rule, the engines which do shunting work in the big goods yards, sometimes never leaving them except to go home to the engine sheds at night, are little six-coupled tank locomotives, with wheels about 4 ft. or 4 ft. 6 in. diameter. They can pull smartly and will often manage a big load, but they are not intended to travel either fast or far. Sometimes they have only four wheels altogether, but then they never go out on to the main lines. The 0–6–0 engines, however, work local goods trains as well as yard shunting, and make short journeys to other yards, to the docks, and other places.

Near big towns there are usually large shunting yards to which the main line goods engines bring their trains. These are then divided

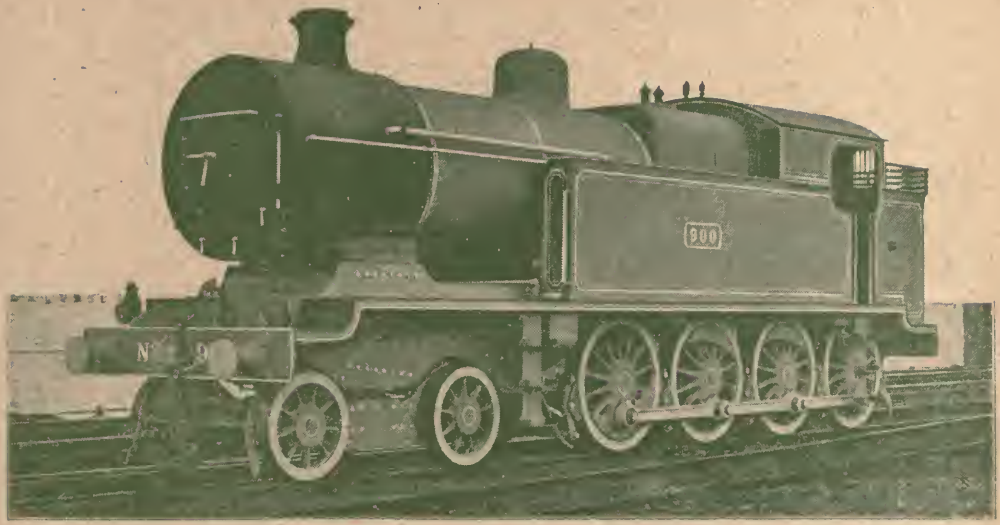
by shunting to form other trains, and these are taken away by the tank engines, to hand them over to other railways, or to deliver them to docks and works in the neighbourhood and to local goods stations.

On many railways, however, there are bigger engines for this work, especially if they may be required to make somewhat longer journeys. A very common type is the 0–6–2. Some of these engines are, in fact, very like certain passenger engines of the same type, but they usually have wheels a little smaller.

In the coal districts the journeys to be made are often fairly short, so that tender engines are not required, though as the loads are heavy, and frequently there are stiff gradients to be climbed, the tank engines used have to be big and powerful. On some railways there are big 0–8–0, 0–8–2, 2–8–0 and, occasionally, 0–6–4, 4–6–2 or 4–8–0 tank engines used for this work. But the chief demand for very powerful goods tank engines is where what is called "hump" shunting is done.

At a suitable place in the yard the line is constructed so that from one side it rises to a summit and then falls steeply for some distance on the other side. The engine pushes a train of wagons up the incline of the "hump," then the shunter uncouples the wagons, in twos or threes as the case may be, so that they run away down the slope, getting sufficient speed to take them into the sidings beyond, according to the points set by the pointsmen. This saves the engine from

0–8–4 THREE-CYLINDER SHUNTING TANK ENGINE, GREAT CENTRAL RAILWAY.



A MONSTER SHUNTING ENGINE, GREAT SOUTHERN & WESTERN RAILWAY, IRELAND.

having to keep going to and fro as in ordinary shunting, but of course the shunters and pointsmen have to be very expert in noting the labels which show where wagons are to go, and in moving the points so that each lot of wagons passes to its proper line.

But as the engine has to push the wagons up a severe incline, and the load will often be heavy, it has to be very powerful. Therefore, most of the engines which do " hump " shunting are eight-coupled, and some are very big machines. On the London and North Western and Lancashire and Yorkshire Railways they are big 0–8–2 tank engines ; but on the Great Western Railway the wheels are just the other way round, 2–8–0.

In some places even these are not enough, and so the engines are larger still. It is not sufficient that the engines shall be able to push a big load—they must do it smartly and quickly. Both the Great Central and the North Eastern Railways have " hump shunters " with big boilers, three cylinders instead of two, and a bogie in place of a two-wheeled truck, in addition to the 8-coupled wheels.

The Great Central engines weigh 97 tons, so that they are very far from being toys. They have the bogie at the rear end, their wheel arrangement being thus 0–8–4. On the North Eastern Railway the engines are not quite so big and they have the bogie in front, 4–8–0.

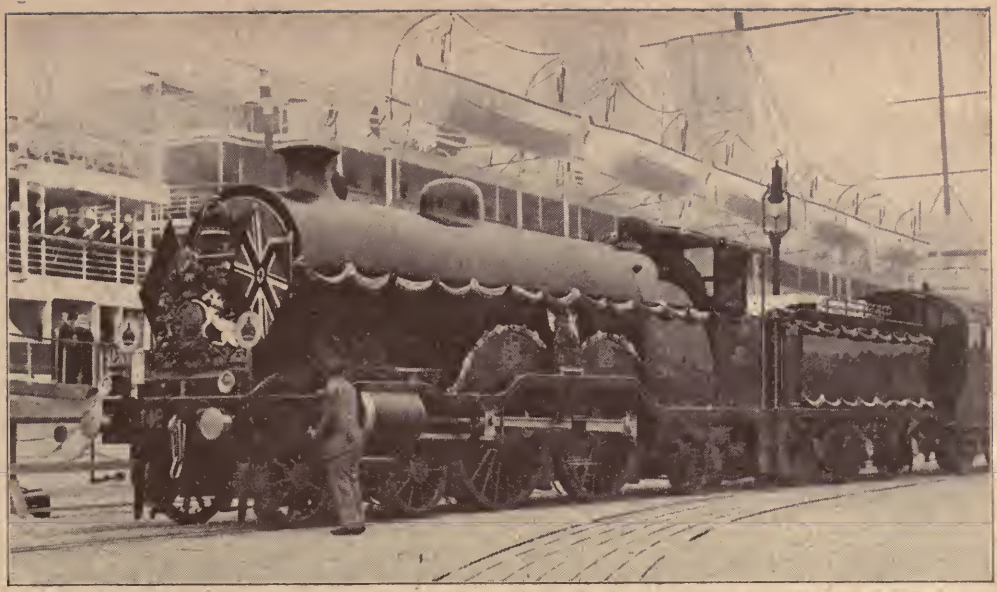
Although eight-coupled engines are chiefly used for coal traffic they are also employed to some extent for other work. Abroad,

there are even larger engines, some with ten wheels coupled, but those with eight coupled wheels are quite big enough, as yet, for British requirements.

A few 4–6–0 and 4–6–2 goods tank engines are used in Great Britain, and there are some with eight coupled wheels only (0–8–0), but the usual classes are 0–6–0 and 0–6–2 for ordinary work, with the 2–8–0, 0–8–2, 4–8–0, and 0–8–4 types for special duties.

Years ago many of these engines had the water tanks fitted as a saddle on top of the boiler, and were therefore termed "saddle tanks," but now very few such engines are built, the usual arrangement being to place the water tanks alongside the boiler, as in other classes of tank engines.

THE KING'S DAY SALOON ON THE ROYAL TRAIN.



[*Sport & General.*

ROYAL ENGINE AT PORTSMOUTH ON THE RETURN OF THE KING AND QUEEN FROM THEIR CORONATION TOUR IN INDIA.

Royal Trains

MANY years ago Queen Victoria stated that she hoped the railway officials took as much care of their ordinary passengers as they did of herself when travelling. Unfortunately, it would be quite impossible to treat the ordinary passenger in the same way, for a day's time-table could never be carried out; but there are good reasons for all the special precautions that are taken when royal people travel. For one thing our King and Queen and the Royal Family belong to the nation. Secondly, there are certain people about who would like to cause an accident as a means of killing a royal personage, and although in this country we are thankful to say such people are few they still have to be considered.

In some countries the rulers are not by any means so well liked as in Great Britain, and the railway officials have a worried time when royalty or other great personages are travelling. Here, also, when foreign kings and queens or presidents are travelling on our railways they have to be looked after almost as carefully as is necessary in their own countries.

For ordinary journeys royal personages often travel in a saloon attached to one of the regular trains, but for all important journeys, special measures are taken.

Several railways have constructed special trains for the King and Queen, and these are really palaces on wheels. They include sleeping-cars—with proper bedrooms, not sleeping berths ; dining-cars, in which meals are served just as in a royal palace ; saloons ; and compartments for servants, attendants and others. The trains used by the West Coast and the East Coast Railways are like this, and will carry a hundred or more people on some journeys. On other railways, such as the Great Western, the Great Eastern and the South Eastern and Chatham,

SALOON FOR THE USE OF THE PRESIDENT OF THE ARGENTINE REPUBLIC.

the trains are suited for day journeys only ; but if a royal journey of an unusual kind has to be made the train of another railway is sometimes borrowed.

At the starting and destination stations the platforms are covered with crimson carpet, and frequently they will be decorated. As a rule the chief officials and the Chairman of the railway will be there to receive the King or Queen, and some of them travel with the train.

The engines and drivers are carefully selected, and generally the

THE QUEEN'S BOUDOIR.

[*Sport & General.*

THE QUEEN'S APARTMENT IN THE ROYAL TRAIN USED BY THE KING AND QUEEN IN INDIA.

locomotives are decorated. The Locomotive Superintendent, or one of his principal assistants, usually travels on the engine.

In many cases a pilot engine is sent in advance of the royal train. This engine travels by itself, about ten minutes in front, and after it has gone by all trains which are passed must stop, and no shunting work may be done or points moved until the royal train has gone by.

BEDROOM, KING'S SALOON, GREAT NORTHERN RAILWAY.

This compartment, 14 feet long, is enamelled white and furnished with inlaid mahogany and fine old rose-coloured silk damask. When used for day journeys the bed is taken out and the compartment is made into a dining-room.

Each signalman has to see that everything is done properly, and to signal the royal train by a green flag in addition to the ordinary signals. Every level-crossing gate must be locked as soon as the "pilot" comes along, and men are placed at the principal points, and along the line wherever thought desirable. As a rule, a policeman is stationed on every bridge crossing the railway; and the stationmaster has to be on every platform passed.

[*W. W. Stewart.*

THE ENGINE WHICH HAULED THE PRINCE OF WALES'S TRAIN ON HIS TOUR THROUGH NEW ZEALAND IN 1920.

All these and many other measures are taken as safeguards in case of accident, and in other countries they have all proved to be necessary, though fortunately in this country there has never been an accident to a royal train.

Some people think that when the King travels he does not pay his fare. No doubt most of our railways would be very pleased to convey him on those terms; but in actual practice the usual rates for special trains and the fares of all on board are paid.

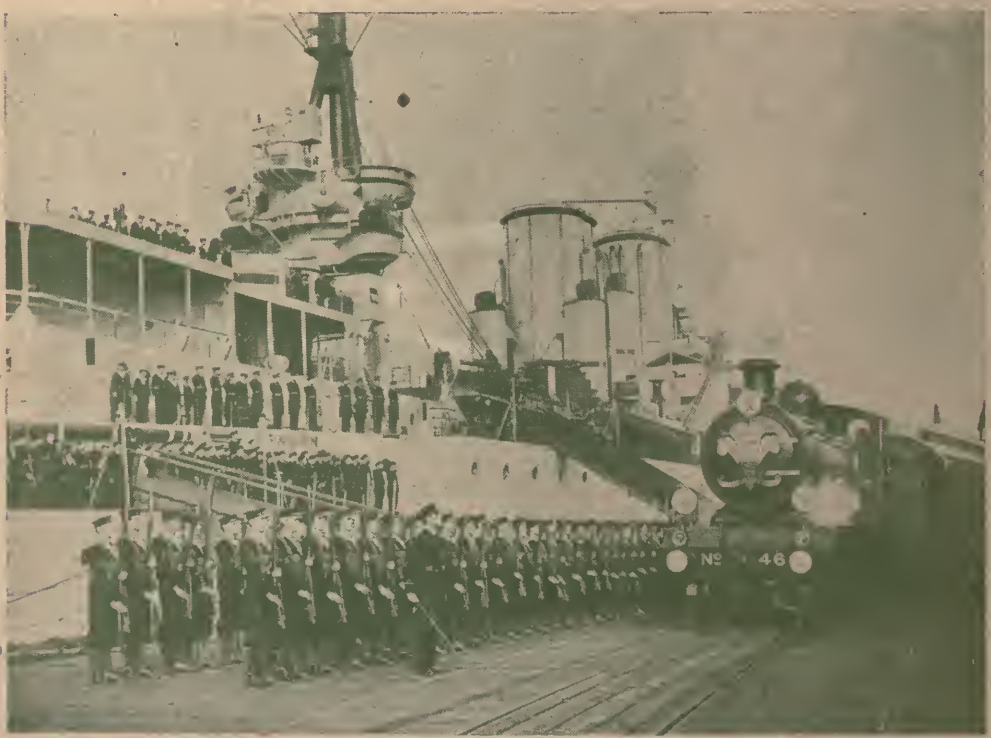
The decoration of royal engines depends, of course, upon who is travelling and the purpose of the journey. Sometimes it is very elaborate, sometimes it is simple. Frequently the national coat of arms is carried in compliment to the travellers. When it is known that royalty is travelling, there will often be crowds of people waiting at various places along the line to give the train a cheer as it passes.

CANADIAN PACIFIC ROYAL TRAIN USED BY THE PRINCE OF WALES DURING HIS TOUR THROUGH CANADA IN 1919.

ROYAL TRAINS

Sometimes a British King or Queen, or a Royal Prince, goes to visit one of the great Dominions belonging to the British Empire, and for those trips the railways always make special provision. Thus, when King Edward VII, and later King George V, went officially to India, Canada, Australia and New Zealand, magnificent royal trains were built. And in 1919 the Prince of Wales made the magnificent royal train, provided by the Canadian Pacific Railway, his home during nearly the whole of the three months he spent travelling to all parts of Canada. During the visit to Australia and New Zealand, which followed in 1920, a great deal of time was spent in royal trains, but, in this case each State had to make its own arrangements, owing to differences of gauge, and the seas which divided several of them.

Now and then a royal train has to be used for another and a sadder purpose; for the sovereign has to be conveyed to his or her last resting-place. Then the engine, instead of gay flags, carries a wreath of immortelles. J. F. G.



[*Topical.*

THE PRINCE'S TRAIN.

The Prince of Wales disembarking from the *Renown* at Portsmouth, and about to enter the Royal train. Notice the Prince of Wales's feathers on the engine.

A CANADIAN PACIFIC TRANSCONTINENTAL EXPRESS.

The Canadian Pacific Railway, familiarly known as the "C.P.R.," is the great highway across Canada, connecting the Atlantic with the Pacific. "In building a railroad we shall build a nation," said the

[*H. Fayle.*

A QUAINT TRAIN, DINGLE STATION, TRALEE AND DINGLE LIGHT RAILWAY.

The Red Flag Man

The Story of a Railway Hero

WHEN you take a ticket for Vancouver, British Columbia, you receive a booklet which describes the marvellous scenery of the line and the grandeur of the Rockies, but no mention is made in it of the red flag men, or of what they mean to the passengers.

From your Pullman window you see a panorama of beauty, stern and wild and free, gliding by you as you lie dreaming in your lower berth ; you see, if your mind has eyes, the first chapter in the history of a great nation, but you don't see the red flag men.

They are like the coal from which the power is obtained which propels your locomotive, humble, unobtrusive, but necessary.

Growler was a red flag man. His real name was Grosvenor, and he had, as a boy, dreamed of the "service" and a Victoria Cross. After a career of failure at school, caused principally by his inability to understand that figures had anything to do with fighting, he had awakened to find himself in the service of the Railway Company, the discontented wielder of a red flag, a private in the ranks of a great industry, known to his comrades as Growler, because he could see no glory in the dull duty by which he had to earn his bread.

For the year that he had served the great trains had gone safely ; they had gone safely for ten years before his advent on the line ; there seemed no reason why they should not always go safely, and therefore the monotony of his job had made Growler slack.

What chance was there, he argued, of anyone distinguishing himself at such work ?

At first Growler had seen some dignity in his service. A thousand lives lay in his hand. But that had all passed. By daily use his work had become merely a monotonous "grind," so many miles out and back, so many times a day and night, in any weather, for small pay, unnoticed and unknown.

His beat lay east and west of him as he sat, a long level run in the flatter part of the foothills.

There were no giant peaks to stir the imagination, no impending snow-slides to suggest great danger.

It was just a piece of rolling cattle country in the spring, through which a broad and turbid river wound in curious loops.

At the moment anyone but Growler would have noticed the ominous roar of that river.

He had heard it incessantly for so long that its noise had become part of his normal environment, like the vast spaces, the smell of the sage bush, and the gloriously-tinted velvet of those rolling uplands.

All he saw was "old Bill's flats," and the long parallel lines of the Company he served.

For an hour he sat in front of his cabin, immovable as the boulder he sat upon, whilst his mind went back to the rectory in which he was born, and to a little case of medals which lay on the drawing-room table of that West Country home.

The Grosvenors who had won those things had had their chances ; why should he never have his ?

Then a hawk lit upon a rock two hundred yards away. Taking his Winchester, Growler lay down, and nestling his cheek lovingly against its stock, sighted at the bird.

There was a long pause whilst the man held his breath, and then the bird fell, a broken handful of bones and feathers.

"I don't know that figures would have improved my shooting," muttered the man, and then as the sun was beginning to set, he boiled his billy and ate his solitary meal.

About midnight it would be his duty to ride his machine along the line to see that all was clear for the west-bound train. He ought to have secured some sleep during the day, but he had had a bad day of it, thinking too much of what might have been, and was therefore, when

the moon rose coldly over the polished bars of steel, "a bit jumpy." Besides, his lame leg had been troubling him.

The river's voice, which he rarely noticed, had become audible to him, and familiar bluffs took on strange and threatening shapes.

He looked at his watch.

In another hour the west-bound express would be along, bearing with it a load of careless sleepers, lucky people who had their chances, he thought. He mounted his machine and went east.

At the first culvert he dismounted.

It was all right still, but he had had no notion that the snows were going so fast.

If such weather continued there would be floods and washouts soon, and surely the roar of the river was louder than it had any right to be? He stopped to look at it.

It was impossible, of course, and yet in the uncertain light it looked to him as if it was running bank high, and the way of it was like the way of a tide rip.

When he reached the trestle bridge he found the light had not fooled him.

There must have been a cloud-burst of some kind up stream. Snow, however rapidly melting, could not have so swollen the river since morning, but even as the river ran, she raged uselessly against the stout piers which supported the Company's bridge.

Growler covered his twelve miles without finding more than an occasional stone upon the track, and then he sat down again upon his boulder, to wait until the smoke-plumed monster with its line of brilliant eyes should flash by and be gone.

As usual, his thoughts reverted to the might-have-been. He saw himself a leader of men, as others of his name had been, and he ground his heel into the little red flag at his feet which was his badge of servitude.

All he asked of fate was some big thing to do, some enemy worth fighting. Why should he be shut out of the arena of men, picketed for life between a river and a railway line?

And as he thought the old bitter thoughts, the river, like a vast and tawny dragon, tossed white crests in the pale half light, and raved on beneath him, stronger than any army of man's making. Surely that was big enough: an enemy sufficient for any man's pride.

Even Growler listened to it now.

The threat in its voice was unmistakable, and yet he missed the message of it. The loop of the river round which Growler's beat ran was horseshoe shaped, but though this horseshoe was twelve miles round its outer curve, the heels of it were so close together that the flagman's cabin and the trestle bridge standing on either heel of the shoe were barely half a mile apart.

In the grey moonlight Grosvenor could see no details of the trestle, but he could see, though dimly, the bulk of it against the sky.

Just half an hour before the scheduled time at which the west-bound express should cross the trestle, a huge buttress of gravel and rock, which had stood for centuries knee-deep in the river's brim, went down with a roar, and was mixed in a moment with the heavy flood.

Things were growing serious, or might soon become so. Growler's spirits rose, and his brain became active.

From habit he looked towards the trestle, not because he thought any flood like that could matter to the great bridge, but just from habit.

And yet what nonsense was this ?

The light was no worse than it had been, but for the moment he could see no trestle. That dim bulk which had always loomed on the far side, where the trains crossed from north to south of the river, had gone.

The red flag man covered his eyes and waited ; when he uncovered them they told him the same impossible story.

There was no trestle !

In a moment he was face to face with the great thing he had waited for. As the river had swept out the gravel buttress so it had swept out man's bridge, and there was no longer any way over for the express.

Way over ? No ; but there was a way in !

Roaring along at her night speed in the flat, with hundreds inside her, sleeping securely in the knowledge that unsignalled she was safe, the express would dive headlong into that hideous flood.

It was his business to signal her.

The enemy was through the lines. He, Grosvenor, the sentry, had been sleeping at his post, and the giant roaring below was laughing at "another surprise of the British forces."

No ! by Heaven, no, that should not be.

He tore his machine from its place, and swung it on to the track, but before he had mounted his brain had told him that that scheme would not do. He was cut off by the river. Even if he could ride

the 12 miles in 25 minutes, which was impossible, he would, at the end of his ride, be on the wrong side of the river.

There was where he wanted to be—there, there, only a mile from where he stood, and there was no way except across that swirling flood which crushed earth's buttresses, and made matchwood of man's bridges.

It was stronger than an army ; how could one man struggle against it ? Ah ! but this thought braced him. He had asked, day and night for years, for some deed to do ; he had boasted to himself that he would have charged an army to win the V.C.

Here was the deed ; where was the man ?

To attempt it meant certain death. Those are the deeds for which England sometimes pays with glory. Yes, but even to a red flag man life is dear. "Even to a hero," some voice seemed to reply, "glory is not cheap." It never is cheap except when it is that of another man, read of in the press.

But the right blood was in Growler, so that as the voices answered each other in his brain, his game leg had taken him down to the river's bank, and his clothes were dropping off him on to the boulders over which the spate lapped and hissed.

For one long minute he stood shivering on the brink of the impossible which had to be done, and then he heard the distant roar of the coming train. She was still two stations away.

"It was my sentry go," he muttered, and the next moment a roar of bitter laughter came up from the river's bed, for the strongest of the forces of nature had a human heart to play with and conquer.

Aye, but it was island-bred that heart, and the God whom islanders forget too often loves the men who fight against long odds, so that though the fuming water rolled Growler over and over like a wandered log, he missed the other wreckage of which the river was full, and near mid-stream was still making a stroke or two towards his goal.

Growler had expected to die at the first plunge, good swimmer though he was, so that his first few strokes were made almost under protest, as being too ridiculous against such a current.

Even when half-way across the man barely did more than wonder why death was so long delayed ; but when he saw the further side he remembered why he was in that deafening, hustling flood, remembered the great live thing that was racing to its doom, and set himself to cover that last half of the course with cool, calculating courage.

His "rotten leg," as he called it, was more useful in the water than on land, and though the great surges tossed him at one moment and buried him the next, they gave him breathing spells in which to edge a foot or two nearer the shore, until at last an insweeping rush sent him blundering amongst some submerged boulders.

He was utterly spent, and something had struck him besides the boulders, so that his whole body seemed dead on one side.

"Hit, I guess," he muttered half consciously, "that's when the good 'uns go on," and lifting his limp body out of the water, he crawled weakly up the bank. From the top of it he could see the line, and clinging with the tenacity of a bulldog to his last remnant of life and consciousness, he tottered towards the oncoming train.

So far it was well, but though he thought that he was running he could not breathe. He knew that he could not keep his senses much longer, even if he had them still, and there was a strange air humming in his head.

Ah, yes, those were the bagpipes, no doubt. They always play when men win the V.C., and that pain in his leg was another wound.

Luckily, at that moment a sound he knew called him to himself. The metals between which he ran whispered to him, then a strong live pulse drummed in them, and in the east a glow crept along the rails towards the runner which was neither the glow of moonlight nor of dawn.

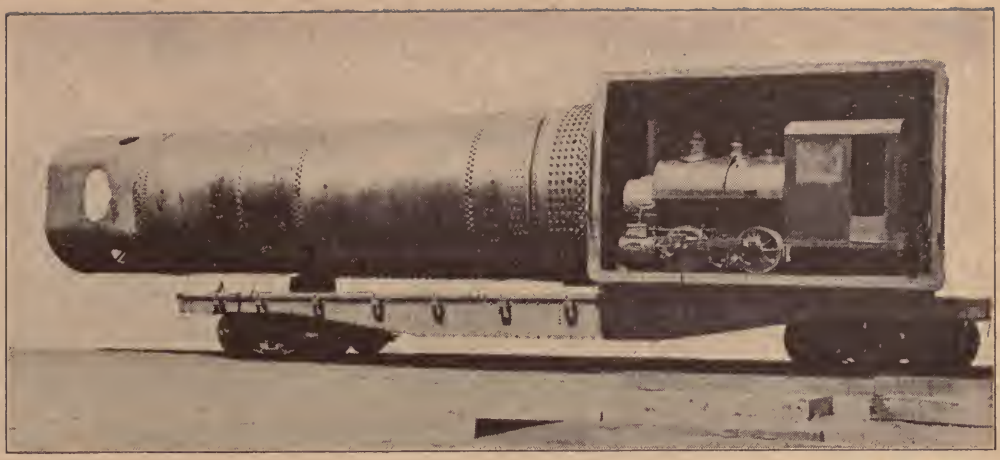
Then Growler knew his duty and won his cross. He could make no proper signal. He had neither lamp nor flag.

Naked he stood save for his shirt, and a figure standing waving that garment from the side of the track might be seen or might not.

In the middle of the track he *must* be seen, and in the middle of the track he stood, naked, foursquare to the death he realized, waving his red shirt for a warning to others, and though the driver jammed on the brakes with a savage western remark, which the recording angel mistook for a prayer, the brakes could only sigh over that which they were not strong enough to save.

When the King of kings pinned on Growler's Victoria Cross, I wonder if He told him that the best soldiers don't hunt crosses, but just find them in the course of duty?

CLIVE PHILLIPPS WOLLEY.



[*Fleet Agency.*

AN ENGINE IN A FIREBOX.

A boiler built for the Virginian Railway. The engine of which the boiler forms part will haul 7,750 tons at 10 miles an hour. It has 16 driving wheels, and weighs, with tender, 340 tons. The firebox will hold a switching-engine.

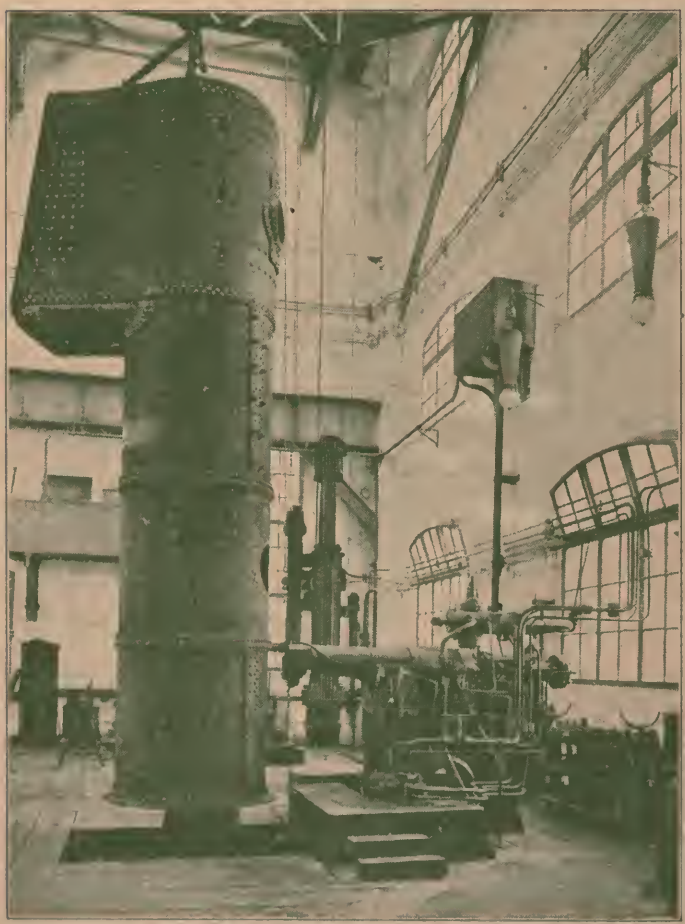
Engine Building and Repairing

BEFORE a single part of a locomotive can be made, complete drawings, consisting perhaps of a hundred large sheets, have to be prepared, showing every detail, giving the exact sizes, and stating what materials are to be used. To get these drawings ready may keep a score or so of draughtsmen busy for weeks or months, but not until they have all been passed by the Locomotive Superintendent or the Chief Mechanical Engineer can anything be done in the works. The drawings are then copied on tracing-cloth and given out to the foremen of the various departments, each man receiving only the drawings relating to the work to be done under his charge.

Most of the great railway works consist of many separate buildings though in a few cases all the work, or nearly all, is done under a single roof, in one enormous building. But whatever the arrangement, each department is concerned only with its own class of work.

The boiler is the largest and most notable feature of a locomotive, and we will therefore visit the boiler shop first, though it is usually the noisiest place in the works. Most of the machines here are large ones, for they have to work on great plates of iron and steel half an inch or more in thickness. To cut the plates to the correct sizes shearing machines are used; these will cut through a half-inch steel plate as easily as through a sheet of paper, though of course the power

required to do so is very great. As the plates will presently be riveted together it is necessary to cut holes for the rivets along each edge; this is done by punching-machines which will pierce ten or twenty holes at a time. Single punches and drilling machines are also provided for making single holes. The boiler plates have then to be curved, so that when put together they will form a barrel; this is done by passing them between huge rollers, which bend them as required. There are also machines which bend over the edges of plates to form flanges, and many other machines, some large, some small, for various purposes. And, of course, there are the pneumatic riveting-machines which, together with the hand riveting that is also going on, are principally responsible for the terrible noise of this shop.



HYDRAULIC RIVETING MACHINE.
A boiler and firebox in course of construction.

Many parts of a locomotive are cast in the foundries by pouring molten metal into moulds of the required shape. The patterns are made of wood in the pattern-makers' shop, but metal patterns are also used for some purposes. They are placed in a moulding pit or a moulding box, and sand or loam is packed tightly round so that the pattern can be removed, leaving a mould of the exact shape required.

In most cases there are two separate foundries, one for iron and one for brass. In the iron

THE BOILER OF ONE OF THE WORLD'S BIGGEST LOCOMOTIVES.

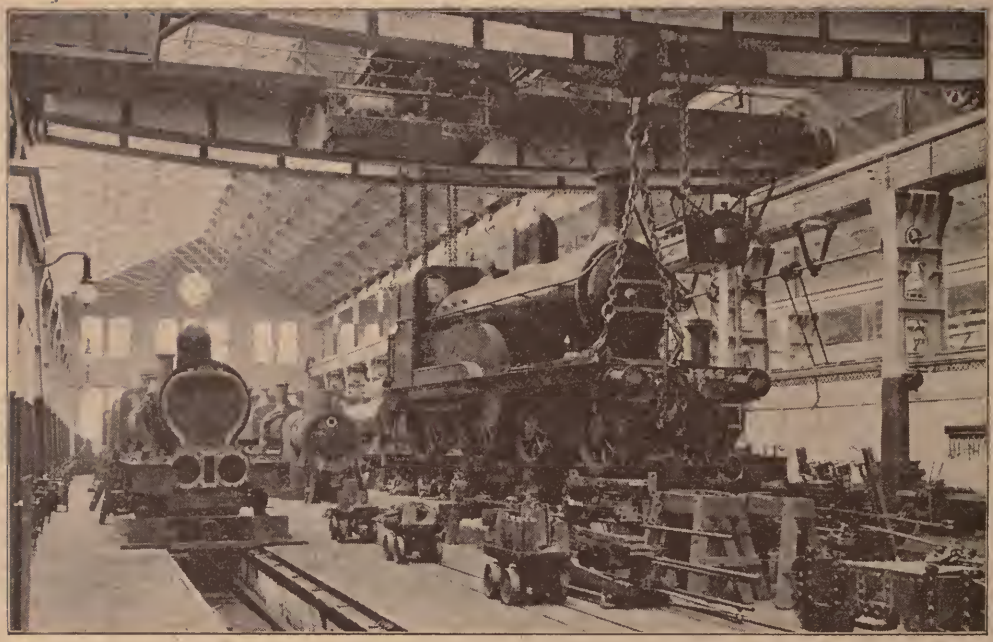
The tubes are 24 feet long and the total length of the firebox is 13½ ft. The diameter of the boiler at the largest ring is 8½ feet. The locomotive is illustrated on p. 87.

foundry molten iron is poured from a furnace into ladles and taken on trolleys, or by means of a crane, to the moulding-pit, where it is poured into the moulds. Many of the parts made in this way are large, such as cylinders, wheels and the like. In the brass foundry the work is smaller, for it consists mainly of details and fittings.

The forge is another interesting place. Here are steam hammers giving blow after blow upon a mass of white-hot iron or steel, which gradually takes shape as a crank axle, a connecting or eccentric rod, or whatever part is being made. There are also hand forges at which blacksmiths are busily at work, besides many special machines. In some works forging presses are used, and by means of enormous hydraulic pressure they squeeze the metal into the required shape.

But whether cast or forged, a great deal of other work has yet to be done before these parts are ready for use, and we must now visit the various machine shops. In one shop heavy work is being done, such as planing and boring engine cylinders, machining frames, and so on. Another will deal almost entirely with rods, eccentrics, and the like. In the wheel shop great engine wheels are turned in huge lathes, and somewhere else axles and cranks are being machined.

Then in other shops smaller work is being dealt with, scores of lathes of all sorts and sizes being in motion. Planing and shaping machines, drills, polishing and other machines are in use, together with automatic machines which turn out complete bolts, nuts, screws, rivets, etc., apparently without attention. In most cases the brass work is done in a separate shop. Then at the sides of the machine shops, or



LIFTING A LOCOMOTIVE BY OVERHEAD CRANE.

in a special part, are the fitters' benches, where all the hand work is done.

We must now turn to that most important place, the erecting-shop. Here all the parts we have seen under construction in other shops are brought together. First of all the main frames are set up on trestles. Then the cylinders and the other parts of the framework are attached, together with the axle boxes and so on. Next the boiler is fixed in position and most of the upper work of the engine added. The wheels and axles are then placed under the engine, and after the various rods have been fitted, the valve-gear set, and all the numerous fittings added, the engine is ready for its steam trials.

It is first tested in the works, and is then sent out for a run down the line. Then it is sent to the paint shop, and after it has received its seven or eight coats of paint and been properly lined out, it is ready to take its place in working trains.

So much for new engines. But we must not forget the engines which are already in service. They also require attention, and in fact they provide enough work, on a great railway, to keep a large works busy, quite apart from the construction of new engines.

After every day's work each engine is carefully examined, and

frequently small repairs have to be made so that it shall be ready to go out again next day. For dealing with these repairs every "running shed," or depôt where engines are stabled, has a small repair shop with several lathes, a forge, and perhaps a few other machines.

Now and then, however, an engine requires heavier repairs and may have to be laid up for a few days, or even for a week or two. At the larger running sheds comparatively heavy work can be done. Here the repair shops will contain a wheel lathe for turning up the tyres, and in one corner of the shed there will be a crane or shear-legs for lifting engines so that the wheels can be removed.

After working for a year or two every engine has to be thoroughly overhauled, and for this it is sent to the principal works, where it is examined in every detail and possibly almost taken to pieces. While this is being done the engine may be out of service for several weeks or months, especially if it has to wait its turn for attention, but when it goes out again it is ready for another long period of hard work.

But in the course of a few years something more becomes necessary. The boiler has become so worn out and untrustworthy that a new one must be fitted, and this time the engine is probably taken quite to pieces, and so many new parts substituted for old ones that when it is again turned out it is almost a new engine.

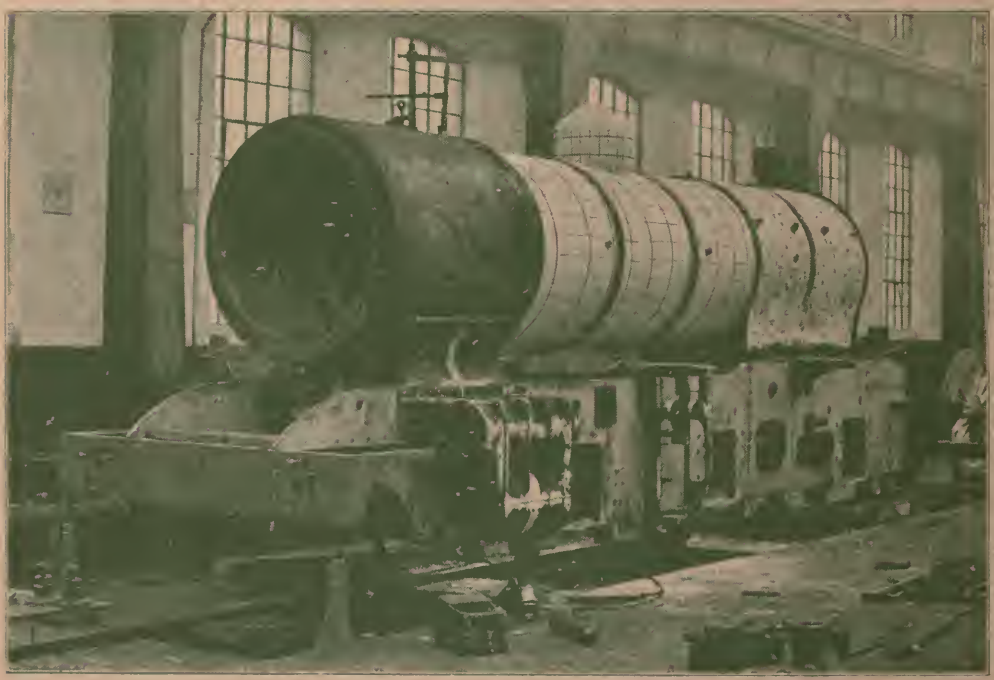
Alas! there is a limit to this, and at last the time comes when it

LOCOMOTIVE REPAIR SHOP, NORTH EASTERN RAILWAY.

is decided that the engine is not worth reboilering and rebuilding. Next time she comes in for heavy repairs she is taken instead to the scrap yard. Here all the parts that can be used again are taken off, and the remainder is broken up. Some parts are melted down to make new metal, some are sold for old iron or brass, and that is the sad end of an engine which has perhaps run many hundreds of thousands of miles, and conveyed millions of passengers or hauled millions of tons of coal and goods.

It is astonishing what "life" there is in some engines. The "Charles Dickens," a London and North Western locomotive, in the course of about twenty years ran over 2,000,000 miles. An old Great Western engine, the "Lord of the Isles," went nearly 790,000 miles without even being once renewed. Every engine has a plate showing the shop from which it came and the year in which it was built; and it is surprising to notice how old some of the engines still in daily use really are. Many engines have run a million miles before having to be broken up.

J. F. G.



A GREAT NORTHERN LOCOMOTIVE UNDER CONSTRUCTION, SHOWING BOILER AND CYLINDERS ATTACHED TO THE FRAME.

[*H. Fayle.*

LISTOWEL AND BALLYBUNION RAILWAY, IRELAND.

The line is built on the Lartigue principle, the trestles bearing the single rail being about 5 ft. high. The engines weigh 10 tons, and have an average speed of 18 miles an hour. The railway, opened in 1888, is 9½ miles long.

Railways Queer and Quaint

WHEN, in the closing days of the nineteenth century, a Bill for the construction of a mono-rail line between Liverpool and Manchester was rejected by Parliament, most people regarded the proposal as something new in railway construction. In this they were wrong, for as long ago as 1821 a Mr. H. R. Palmer patented an invention for a single line railway, and in addition a railway consisting of one rail only was, and still is, working in Ireland.

Mr. Palmer's idea was to have a line elevated on pillars and carried across country. The plans showed that the wheels would be placed on the single rail tandem-wise. From each wheel would hang an iron-hooked rod, upon which a truck (parallel with the line, but not touching it) would be suspended. Upon the other side of the rail, as a counterpoise, would hang a similar wagon. Thus two wheels would support, pannier fashion, two goods trucks, which on an ordinary line of railway would require four wheels each. The motive power was to be a horse, and it was estimated that twelve or fourteen loaded trucks could thus be drawn upon a single railway. Trains travelling in opposite directions were to pass by means of sidings.

A line on Mr. Palmer's principles was, in 1825, actually laid at

Cheshunt, Hertfordshire, being employed chiefly for conveying bricks from the town across the marshes for shipment in the River Lea. It is said one horse was capable of drawing, at the usual pace, about fourteen tons, inclusive of the trucks.

Mono-railways have been in operation in various parts of the world for many years. One system, known as Caillet's, has been used in new countries, not so much as a competitor with light double-rail systems as to take the place of other forms of wheel transport, such as wheel-barrows, carts, and so forth. Caillet's system is traction by side leverage, and the cars or trucks have two or four wheels running in the same plane on a single rail.

Such small propositions as those of Caillet's are thrown quite into the shade by the operations of the Listowel and Ballybunion Railway, in County Kerry, on the western side of Ireland. This line is built on the one-rail principle known as the Lartigue single elevated rail system, so called from the inventor, Mons. Lartigue. The line, 9½ miles in length, was opened in 1888, after occupying only nine months in construction.

The permanent way consists of trestles, 3 feet high, supporting a double-headed rail. The trestles rest upon steel plates, which are secured to transverse wooden sleepers. Light guiding rails are fixed on each side of the trestles at a distance of 2 feet 4 inches below the level of the carrying rail. The rolling stock is suspended from the bearing rail and kept in position by the guiding rails, which take the lateral pressure.

The railway is worked by steam locomotives. Each engine has two boilers, one parallel with the other, and connected with pipes, thereby equalizing the water level and steam pressure. The locomotives are carried on three coupled wheels, 2 feet in diameter, which are situated between the boilers, the middle wheel being the driver. The total weight of each engine in working order is 10 tons. They usually average about 18 miles per hour, but can work up to 27 miles.

The rolling stock is also carried on a single row of wheels, the carriages being built with the lower part in two sections, between which the wheels are placed, and their peculiar design makes derailment impossible.

Queer and quaint as the Listowel and Ballybunion Railway may appear to travellers from afar, it has a very useful place in the scheme of things in the district it serves.

[*E. N. A.*

AN ELECTRIC SUSPENSION MONO-RAIL SYSTEM.

The Barmen-Elberfeld Mono-Railway runs over streets, canals and rivers, the cars being suspended from a single rail.

In 1880 a Mr. Collett of Cardiff designed an overhead railway. His steam engine and coaches were to be suspended by framework to wheels running on top of the overhead rail. Since that time suspended electric railways have been put into successful operation on the Continent of Europe. The Barmen-Elberfeld railway is on this system in a very perfect form, as the illustrations plainly testify. Another suspension railway at Loschwitz, Saxony, opened in 1901, claims to be the first mountain railway of its kind for the conveyance of passengers. The railway is 820 feet long, with a gradient of 32 per cent. Each car holds 50 passengers. A steel cable connects the two trains and locks them firmly together.

It would be strange if America could not produce something in the

A CAR ON THE KEARNEY HIGH-SPEED RAILWAY.

The cars are designed to run on a single bearing rail, being maintained in an upright position by an overhead guide rail.

way of queer and quaint railways. One is a genuine switchback railroad, known as the Mauch Chunk Summit Hill and Switchback R.R., and is now used entirely as a pleasure road. This piece of track is said to be the oldest railroad in America, with the exception of one of two or three miles at Quincy, Mass. The Mount Pisgah plane is 2,322 feet in length, with an elevation of 664 feet, being a rise of about one foot in three. There are two tracks, and upon each runs a safety car, to which are attached two heavy steel bands, each 7½ inches wide. These bands are fastened to iron drums, 28 feet in diameter, in the engine house at the head of the plane, the motive power being two stationary engines of 120 horse-power. The safety car has attached to it an iron arm, which extends from the side of the car, over a ratchet

MOUNT PISGAH TRESTLE BRIDGE, ON THE SWITCHBACK RAIL ROAD, MAUCH CHUNK.

rail between two tracks; should the band break, or anything happen to the machinery, the least backward movement causes the arm to drop into the notches of the safety rail, holding the train stationary. In all the years the railway has been working there has never been an accident to a passenger.

That there is much that is serviceable in both mono-rail and switch-back railway working is apparent. Because such systems are unfamiliar to the majority of British people they may be true to our title "Queer and Quaint," but who can say that these features will not figure largely in railways still to be built? The Kearney High-Speed Railway system, which depends largely upon gravity, is a case in point. In the Kearney system, first publicly introduced in 1908, the cars run upon a single bearing rail which takes the whole weight of the train. The cars are kept upright by means of a single overhead guide rail rigidly braced and supported by standards placed at intervals of 60 feet, so that derailment is impossible unless an actual breakage of the permanent way occurs.

The centre of gravity being very low with electrically-driven cars, due to the motors being suspended on the same centre of lines as the

driving wheels, the pressure of the guide wheels on the top rail amounts to only a few pounds when the car is at rest, and to practically none at all when the train is running at high speed on the straight. It is only on curves, when the running speed exceeds or falls below the normal speed for which the line is constructed, that any appreciable stress is put on the top rail.

With electric traction it is a simple matter to control the speed of trains so that they will travel over any given portion of a line of railway.

The Kearney system is intended for surface, elevated, or tube railways, but it is for the latter that most attention has been paid to its claims. As a tube line the Kearney system would come near to the surface at stations, thus avoiding lifts or escalators. Although for their high speed the Kearney trains would depend upon gravity and electric motive power, one must not suppose that travel on such a line would be on a par with the sensations on a mountain railway at an exhibition. The only time when a passenger would be conscious of the use of gradients would be when seated in a rear car of a long train, and then only momentarily as the car passed from the level to the proposed 1 to 7 grade.

W. P.

THE LARTIGUE ELEVATED SINGLE RAIL.

A full-sized model line was exhibited at Westminster in 1886. The Listowel and Ballybunion Railway was afterwards constructed on this principle.

LONG DISTANCE CORRIDOR MAIL TRAIN, SOUTH AFRICAN GOVERNMENT RAILWAYS.

The Cape to Cairo by Rail

TO many people the most interesting line in the world is that which it is hoped will ere long cleave the continent of Africa from south to north, popularly known as the Cape to Cairo Railway. Of the actual 6,000, or more, miles, only about 3,000 have been constructed; but such has been the progress of the line, since it first began to take form in 1891–92, that, given settled conditions, it is quite likely that the next ten years will see the accomplishment of the scheme in its entirety.

It was at first thought, and many people still seem to believe, that the railway was designed for the sole purpose of enabling a man to travel between Cape Town and Egypt, or *vice versâ*. But, as the late Mr. Cecil Rhodes, who had so much to do with the project, once observed, such a notion is ridiculous. The object of the line, he was at pains to point out to Mr. E. S. Grogan—an intrepid young Cambridge undergraduate, who had done the journey on foot—was to cut Africa through the centre, and the railway would thus pick up trade all along the route. "The junctions to the east and west coasts," wrote Mr. Rhodes, in 1900, two years before he died, "which will occur in the future, will be outlets for the traffic along the route of the line as it passes through the centre of Africa. We propose to go on, and cross the Zambesi just below the Victoria Falls. I should like to have the spray of the water over the carriages."

It will be seen presently that Mr. Rhodes's odd wish, as expressed in the last sentence, was in due course carried out, though he himself did not live to see the trains pass through the spray of the Zambesi. The initial stage of the Cape to Cairo Railway was completed long before

Mr. Rhodes's name became associated with the scheme. This was as far back as 1859, six years after Mr. Rhodes was born, when the first railway in Cape Colony was constructed between Cape Town and the little town of Wellington, a distance of 58 miles, the gauge being 3 feet 6 inches.

Cairo was not the grand objective in those days; indeed, at that period, the regions north of the Cape were largely unknown territory. The discovery of diamonds in 1867, in what is now the Kimberley district, lent the first great impetus to railway construction in Cape Colony, and in 1872 the Cape to Cairo line was extended another 60 miles to Worcester.

In its first hundred miles the railway presents many engineering difficulties, particularly in the picturesque and mountainous region known as Hex River, where it climbs to an altitude of 3,588 feet, and where for twenty miles or so the gradients are 1 in 40 and 1 in 45, with curves of five chains radius. Matjesfontein, that beautiful little oasis in the desert, was passed in due course, and the first train from Cape Town steamed into Kimberley on November 28, 1885. Five years later the railhead was at Vryburg, in Bechuanaland, some 774 miles from Cape Town—a link of quite a respectable size in the great Cape to Cairo trunk line.

A SUDANESE ELEPHANT TROPHY.

The tusks are very fine specimens, as will be seen by comparing their size with that of the men holding them.

It was about this time that the Cape to Cairo scheme first began to be talked about. Mr. Rhodes (then Premier of Cape Colony) was credited with having coined the phrase and conceived the project; but it is open to doubt whether he did the one or the other. The credit for the phrase "Cape to Cairo" should be, I think, given to

STATUE OF GENERAL GORDON, KHARTOUM.

Sir Charles Metcalfe, Bart., the well-known Anglo-African consulting engineer, who first used it about 1889, in an article in the *Fortnightly Review*. There is reason, too, for believing that the conception of the scheme was also his and not Mr. Rhodes's. Certain it is that the project was foreshadowed by Sir Charles Metcalfe in 1888, when he was inspired with the idea of calling the prospective Bechunaland railway the "Central African trunk line."

But it was reserved for Mr. Rhodes to crystallize the idea and catch the fancy of his fellow-men with a seemingly impossible and audacious project.

In 1893 the Bechuanaland Railway Company—now known as Rhodesia Railways Ltd.—was formed for the purpose of constructing and working a railway from Vryburg to Mafeking, a town which was destined to win undying fame some years later in the Boer War—and thence northward towards the great River Zambesi.

Thus was begun what may be called the second link in the Cape to Cairo Railway, and it is interesting to recall that Sir Henry Stanley, the distinguished African explorer, once declared that the whole country—that is, the stretch between Vryburg and Mafeking and Bulawayo—seemed to "have been created for railway making," and offered as "few difficulties as the London Embankment; Hyde Park is extremely uneven compared with it." The section to Mafeking was opened for traffic in 1894, and it was no sooner completed than work was begun, in real earnest, on the next stage. The stretch to Gaberones was opened in the middle of 1895, and two years later the whole section to Bulawayo, in Rhodesia—some 1,360 miles from Cape Town—was triumphantly completed.

Less than two years later Mr. Rhodes came to England with the express object of inducing the Imperial Government to assist him

financially to extend the line in a northerly direction to Lake Tanganyika, some 800 miles away. The idea then was to carry the Cape to Cairo line from Bulawayo to Abercorn, at the southern corner of the great lake, and thence alongside its eastern shores through what was then German territory to Uganda and so, upwards and onwards, to Gondokoro, Khartoum, and Cairo. But the Imperial authorities took so long to think about the matter that Mr. Rhodes, ever impatient of delay, began to look elsewhere for the help he needed, and eventually found it—the various Rhodesian mining companies subscribing £500,000 and the British South Africa Company, the virtual rulers of Rhodesia, guaranteeing a sum running into several millions.

The Belgian Congo route was ultimately decided upon, and the line proceeded stage by stage towards the Zambesi, which is about 1,800 feet above the sea level. To Rhodesia belongs the distinction of possessing both the highest and the longest bridges in Africa. The highest bridge is that which spans one of the many curious gorges of the Zambesi, close to the wonderful cataract known as the Victoria Falls. It is 420 feet high, and was erected in the remarkably short space of nineteen weeks. The total length is 650 feet, the central span accounting for 500 feet, between the pin centres. The bridge is

[*Percy M. Clark.*

HAULING A CANOE TO AVOID THE CATARACTS, RHODESIA.

[*A. C. Gomes.*

ON THE UGANDA RAILWAY.

of steel, and was built out from both banks simultaneously. As it is coated with grey paint it is rendered almost invisible against the never-ceasing cloud of spray—the "smoke that sounds," as the natives call it. It is this "smoke," or spray, that envelops the trains as they pass over the great bridge—in fulfilment, as it were, of Mr. Rhodes's desire.

Whilst the great bridge was building in 1905, the laying of the track in a north-easterly direction to Rhodesia Broken Hill—360 miles away—was proceeded with, but *en route* the somewhat formidable river Kafue had to be crossed, and here a bridge upwards of a quarter of a mile in length—the longest in Africa—was constructed.

The death of Mr. Rhodes in 1902 somewhat interfered with the progress of the Cape to Cairo Railway, and when, in 1905, the writer interviewed Sir Charles Metcalfe and invited him to fix an approximate date for the arrival of the iron horse at Abercorn, on the southern end of Lake Tanganyika, the genial baronet politely begged to be excused, saying: "My own opinion is that in the future there will probably be two lines running from Rhodesia Broken Hill—one going up through the Congo Free State to Lake Chad, and right through to French territory, coming out perhaps at Algiers, or some other place on the north coast; the other coming up through German East Africa, and ultimately joining up with Khartoum and Cairo."

The first through train from Cape Town arrived at Rhodesia Broken Hill, 2,000 miles distant, on June 24, 1906, the line being opened for public traffic on September 1 following, but before that happened the next stage of the trunk line—to a point on the Congo border known

as Bwana M'Kubwa, a little over 100 miles north of Rhodesia Broken Hill, was surveyed, and the work of construction was eventually proceeded with, the line crossing the Rhodesian-Belgian border on November 16, 1909.

The importance of the Belgian route lies in the fact that the line is destined to connect with the railway planned to run from Lobito Bay, in Portuguese West Africa, to Katanga, in the Belgian Congo, and which, when through connection is obtained, will very materially shorten the journey between England and Johannesburg—the " Golden City " of the Transvaal. Katanga is almost in the very heart of Africa, and is probably the richest copper district in the world. The intention is to effect a junction with the Cape to Cairo line at Kambove, which is just north of Elizabethville, a town of considerable importance in the Belgian Congo.

The Cape to Cairo Railway then stops short in its progress from the south at Bukama, (about 2,800 miles from Cape Town), which was reached in 1914.

Several short but exceedingly serviceable lengths of line are already in existence—notably that between Congolo and Kindu and, still farther north, that running alongside the river Congo from Ponthierville to Stanleyville. It is to be presumed that eventually the Cape to Cairo railway will be extended in such a way that these two lengths of line will be merged into and form part of the grand trunk line.

From Stanleyville, the Cape to Cairo Railway will run in a north-easterly direction right across to the Uganda border, and so on to Gondokoro, and the River Nile. From Gondokoro, which is about 1,081 miles south of Khartoum, in the Sudan, there is a stretch of country which is regarded as difficult from the point of view of the railway engineer, and exactly what will be done in the way of opening it up and carrying the Cape-Cairo line forward to Sennar, the present railhead of the Sudan Government Railway system, is not yet determined.

That ancient waterway, the Nile, plays a very important part in the last link of the Cape to Cairo Railway from Gondokoro onwards, and the probability is that a considerable time will elapse before the iron horse is in evidence between Gondokoro and Sennar. But it will happen some day—and some day, too, there will be a grand linking up with the short length of line which has already been constructed in Abyssinia, and which at present runs from Adis Abeba, the capital, to Jilutil, at the southernmost corner of the Red Sea. From Sennar,

[*E. N. A.*

RAILWAY MAKING IN THE CONGO.

Natives laying down ant-proof metal sleepers. If wood were used the ants would quickly destroy it.

the traveller can journey very comfortably in the Sudan Government Railway trains to Khartoum, a distance of 430 miles, passing through much interesting and historic country.

As for Khartoum—a city for ever associated with the name and fame of General Gordon, who was martyred there, it is difficult to realize when entering that well-ordered city that not so very long ago the entire district was given over to savagery of the cruellest description. Lord Kitchener, in his conquest of these turbulent regions, rendered signal service—all unwittingly maybe—to the Cape to Cairo Railway, for it was largely through his initiative and zeal that the line, which played an important part in smashing the Mahdi, was constructed for the purpose of bringing up men and munitions of war.

From Khartoum northwards, right through the land of Egypt, with all its glamour and ancient mystery, the last link of the Cape to Cairo system is composed of railway and river steamer, and forms one of the pleasantest and most fascinating journeys in the world. In the eyes of many it is even more fascinating than Rhodesia, in the south, with its wonderful river and falls and its terrible memories of Lo Bengula, the cruel Matabele king, and the undying heroism of Alan Wilson and his followers, who perished in the great rebellion, and to whose memory a noble monument has been erected on the Matoppo hills, where Cecil Rhodes and his friend and helper, Sir Starr Jameson, sleep their last sleep, almost within sight and sound of the Cape to Cairo railway.

J. Hartley Knight.

RAILWAY STATION, CAIRO.

INSPECTOR, GUARD, TICKET-EXAMINER AND PORTER, LONDON & SOUTH WESTERN RAILWAY.

Railway Uniforms

THE employés of a railway company most familiar to the public are the men who work the trains and the inspectors, ticket-examiners and porters whose duties lie on station platforms. All these, and many others who are not so often seen, such as signalmen, shunters, pointsmen, carmen, etc., wear clothing supplied by the Company; but the clerks in the various offices, mechanics and artisans in the locomotive and carriage works, labourers of many kinds, platelayers, etc., are not included in the uniformed staff. Altogether there are quite thirty different classes of workers who wear a distinctive garb.

The method of clothing the uniformed staff varies considerably among the different companies. In one case a company has a large tailoring establishment and makes all the garments required, but the general rule is for the clothing to be made by an outside contractor with cloth obtained by himself. In some cases the cloth is supplied by the Company, and the contractor merely makes up the garments.

The reader need not be told that an inspector or a passenger guard is clothed differently from a porter. Blue cloth is the material used for the higher officials, whereas stout corduroy trousers are worn by the porters, whose work is of a rougher kind.

When your father pays a visit to a tailor he feels the cloth to satisfy himself as to its weight and texture, but a railway company does much more than that. The cloth is tested in a machine that quickly discloses any weakness in either warp or weft. Chemical tests are used to find out the amount of cotton contained in the cloth. A sample piece is soaked in caustic soda, which will dissolve animal matter but has no effect on vegetable fibres. After a time the wool completely

disappears, and the experiment shows the actual quantity of cotton used in making the material.

The London and South Western Railway garments are issued to the staff in the spring and autumn. Generally trousers are supplied every six months; light coats and vests every other summer; and heavy coats, vests and overcoats every other winter. At the Stores the garments for each man are made up into a separate parcel, duly labelled with his name, grade and place of employment.

TICKET COLLECTOR, LONDON, BRIGHTON & SOUTH COAST RAILWAY.

A PLATFORM INSPECTOR, GREAT WESTERN RAILWAY.

It is not to be expected that those who get new clothes are always satisfied with the fit; but generally the alteration of a few buttons removes all cause for complaint. Some men are more particular than others and want to conform to fashion. If narrow legs to trousers are the popular vogue they will return their garments for alteration.

The official who has charge of these matters on the London and South Western Railway recalls one suit that was returned by a brakesman because it was "much too small." The garments certainly did not look as though such a charge could be laid against them. One of the Store's staff promptly got into one trouser leg, another full-grown man stepped into the other, and the waistcoat was buttoned round the pair of them—and even then the suit was not a tight fit!

GUARD'S UNIFORM, GREAT WESTERN RAILWAY.

Caps and hats are served out yearly. There are a score of styles, with sizes ranging from $6\frac{1}{8}$ to $7\frac{1}{2}$. It is often a much more difficult matter to provide a man with suitable headgear than is the case with a coat or vest, for there is a great difference in the shapes of heads. The members of the clothing staff can relate various amusing experiences, of which the following is an example. A chief inspector returned his hat, complaining that it did not fit, and that the quality was poor. The despised headgear was kept at the Stores for a fortnight. It was then re-labelled, placed in a new box and returned to the inspector, with a note expressing the hope that he would now find no cause for complaint. He replied that the hat was a perfect fit, that the quality was far superior to the previous article that had been forwarded to him, and that he was quite satisfied!

PORTER'S UNIFORM, GREAT WESTERN RAILWAY.

From the clothing stores are also issued the various cloth and metal badges worn by many of the employés. A cloth badge has a year's life, but a metal one is generally in use for twenty-five years. Red and blue armlets are worn by extra porters, pilot men and others.

It is impossible to mention all the articles of clothing that are served out on the different railways to various classes. Some men are supplied with leggings and

mackintoshes; oilskin suits and clogs are required by those whose duties call for the use of water, as in carriage-washing, etc. Blue blouses are worn by men engaged in fruit and meat loading; the sailors on the railway steamers wear blue jerseys; tunnel men are clothed in flannel suits; and electricians, boiler-inspectors, policemen, firemen, dining-car attendants, Royal train officials and the hotel staff all require garments of widely differing character.

GUARD, LONDON, BRIGHTON & SOUTH COAST RAILWAY.

Platelayers, as a rule, are not supplied with clothing by the Company. Some of these men, however, are employed in fog-signalling, cold and cheerless work, for which warm clothing is very necessary. They are therefore provided with thick overcoats, the collars of which are covered with scarlet cloth. These garments are generally second-hand ones that have been returned to the Stores after two

STATION MASTER, GUARD AND PORTERS, LONDON & NORTH WESTERN RAILWAY.

years' wear by officials in higher grades. There are also various other servants, not entitled to new clothing, who are favoured with similar garments.

When you travel on the London and South Western Railway you will notice that all classes of servants wear a red necktie. Each man is supplied with a yard of red Turkey twill at the spring and autumn issues; red silk is furnished only to the highest grades. The neckties alone call for 20,000 yards of twill each year. The red neckties are supposed to have been adopted on account of their usefulness as danger signals in case of sudden emergency.

A great many of the left-off garments of railway employés find their way to the "shoddy" mills for conversion into cloth of the cheapest kinds, but garments that are worth it are fitted with new collars and cuffs and then find a ready sale among farm labourers and other classes whose work calls for rough clothing. The articles for which there is no demand at home are sent abroad. Upon many of the sugar and cotton plantations of India and the West Indies and in the mines of South Africa it is not uncommon to see a native clothed in a strange medley of garments. An inspector's silk hat, a guard's frock coat and a porter's corduroy trousers give a darky the liveliest satisfaction and make him the envy of all his fellows.

"CHOCOLATES!"

How Many Miles an Hour?

NEARLY everyone likes to know at what rate he or she is travelling, especially on long distances and by crack trains. All you need is a watch with a seconds hand.

All along the railway you will see little white posts marked $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$, 10, 15, and so on. These posts are placed every quarter of a mile. Now there are 3,600 seconds in an hour, so that if you were crawling at the not very alarming speed of a mile an hour you would take 900 seconds in passing between each quarter-mile post. We will suppose that actually you take 15 seconds. You must therefore divide 900 by 15—result 60: that is, you are fortunate enough to be travelling at the rate of 60 miles an hour. If you take 30 seconds to pass from one quarter-mile post to the next you are obviously only going at half that speed, namely 30 miles an hour. Of course, this is only a rough mode of calculation and to get the exact speed you would have to allow for fractions of a second. If you are going 40 miles an hour, you will be able to count $22\frac{1}{4}$ seconds between each post; if 45 miles, 20 seconds; if 50 miles, 18 seconds; if 55 miles, $16\frac{1}{4}$ seconds, and so on.

Nearly all railway collisions are "end on." The Great Central Railway Company has constructed a special type of armoured carriage, with "tooth" fenders above the ordinary buffers. Should a collision occur the fenders would be driven together and offer an obstacle of great resisting power.

RACK RAILWAY, MOUNT PILATUS.

This is one of the many mountain railways of Switzerland. The engine works its way up the steep incline by means of

PIKE'S PEAK RACK RAILWAY. COLORADO.

The train climbs through clouds to a height of 14,107 feet. Pike's Peak is said to be the highest mountain in America the summit of which is reached by railway. The line is 9 miles long and has an average gradient of 1 in 6.

Mountain Railways

ALTHOUGH the locomotive engine can do some wonderful things, it cannot, like the tank, climb the side of a house or the slopes of a mountain if the incline is very steep. That is, without special aids, and even then there is a limit to what can be done, for it is not much use making an engine which can get up itself unless it can also take a substantial load of passengers or goods.

In constructing a railway through a mountainous district, therefore, it is necessary to make a continuous track by cutting away rock, building embankments, erecting bridges and viaducts, or boring tunnels, so that a line that will be somewhere near level or not too steep can be made. In other words, the low places must be filled in or bridged, and the high places cut away or pierced through. Hence the many wonderful examples of engineering enterprise in these mountain lines.

Unless the engines are to be specially constructed, they must be very powerful, and often, even when enormous locomotives with eight or even ten or twelve pairs of coupled wheels are used, it is necessary to employ two or even three or four engines to get a heavy train over the steep gradients.

[*By courtesy of the Mount Tamalpais Railway.*

THE TERMINUS OF THE MOUNT TAMALPAIS SCENIC RAILWAY, NEAR SAN FRANCISCO.

From this point stretches a gorgeous panorama of the country round San Francisco, and of the Pacific Ocean.

[*By courtesy of the Mount Tamalpais Railway.*

THE CROOKEDEST RAILWAY IN THE WORLD, MOUNT TAMALPAIS SCENIC RAILWAY, CALIFORNIA.

[*By courtesy of the Mount Tamalpais Railway.*

A LOOP IN THE "DOUBLE BOW-KNOT" ON THE MOUNT TAMALPAIS SCENIC RAILWAY.

ON THE FAMOUS LÖTSCHBERG RAILWAY.

Section of a steep gradient in the Kandersteg Valley. The zigzag road used by vehicles and pedestrians is seen on the right.

In Switzerland, Italy and the United States some of these mountain lines are worked by electric locomotives. This is especially the case on lines which have to pass through very long tunnels like the Simplon (12½ miles), St. Gothard (9¼ miles), Lötschberg (9¼ miles), Mount Cenis (8 miles), Arlberg (in Austria, 6¾ miles), Gunnison (in Colorado, U.S.A., 6 miles), Otira (New Zealand, 5¼ miles), Rogers Pass (British Columbia, 5 miles), and the Trans-Andine (South America, 5 miles). Only a few of these are worked electrically, including the four longest, but there are many others of less length where electric traction is used. In fact, including railways with very long tunnels and others which traverse mountain country where plenty of water power is available, there are quite a large number of remarkable mountain electric railways. There are also lines which still use steam engines and pass through magnificent scenery of a grand and awe-inspiring character.

So far, we have referred to lines which work in the ordinary way, by the adhesion of powerful locomotives on smooth rails. But if the gradient is to be steeper than one in thirty the engine must be helped by a rack rail. There is only one railway of this kind in the United Kingdom, that up Mount Snowdon. Here, as on other very steep mountain railways. the engine pushes the carriage in front of it up the mountain and comes down with the carriage behind. Under the locomotive are toothed wheels worked by the machinery and engaging in the teeth of a toothed rail or a kind of ladder rack placed between the ordinary rails. The engine thus, as it were, "cogs" itself along, and so can get up inclines which it could never sur-

AN ELECTRIC LOCOMOTIVE ON THE LÖTSCHBERG RAILWAY.

[A. G. Wehrli, Kilchberg—Zurich.

ON THE ARTH-RIGI RAILWAY.

This is one of the two lines which climb the great mountain known as the Rigi (more than 6,000 feet high), overlooking the beautiful Lake of Lucerne. From the summit one of the grandest views in the world is obtained.

mount in the usual way, rising even as steeply as one in four or one in three.

There are railways of this kind in many parts of the world, and in some places electric locomotives are used in the same way.

Most of the very steep rack railways are comparatively short; but longer ones have parts of the line when the engines can work in the usual style. In that case the locomotive has coupled wheels for adhesion working, with their operating cylinders, and another set of steam cylinders working the rack pinions. And as many of these engines have to take heavy trains of passengers and goods, instead of single cars for tourists desiring to ascend high mountains, they need to be very powerful.

Examples of some of these special designs are illustrated. Perhaps the most remarkable are those used in South America for crossing the Andes.

The highest mountain line in the world is the Antofagasta and Bolivia Railway, where at Collahvasi a height of 15,809 feet above sea level is reached. The Peruvian Central Railway is 15,583 feet high at the Galera tunnel; while on the Peruvian Southern Railway the highest point is 14,665 feet. On the Denver and Rio Grande Railway in Colorado, U.S.A., a summit of 11,330 feet is reached, and the Trans-Andine Railway touches 10,466 feet at La Cumbra.

Most of these lines are worked at their highest points by rack and adhesion locomotives of types illustrated, the only exception being, in fact, that in the United States, on the Denver and Rio Grande Railway.

Sometimes, instead of a rack rail, a central rail is fitted, adapted to be gripped between horizontal wheels under the engine. This is known as the Fell system, and there is a very fine example in New Zealand, where trains are taken over part of the line by three or four Fell engines, placed here and there in the train, instead of all being in front or behind, or some at both ends.

Cableways are often used for conveying goods across valleys, and there are now a few in Italy and Switzerland, where passengers travel in this way. During the war soldiers were often conveyed in this manner in the Italian mountains. Some of these lines now use small enclosed carriages for passengers to travel in.

CENTRAL HALL, PENNSYLVANIA STATION, NEW YORK (PENNSYLVANIA RAILROAD COMPANY).

The Largest Railway Stations in the World

A RAILWAY STATION may be large in many ways. There may be fine grounds, and even gardens, as at some of the great Continental stations. In fact, in Vienna the "Southern" terminus seems to be more garden than station. In other instances there is a huge hotel, or a block of offices, while in America the idea seems to be to provide shops of all kinds, restaurants, and so on. Abroad, too, magnificent buildings are often provided for railway stations the traffic of which is not at all great.

The most remarkable station of all combines all these characteristics except the gardens and grounds—space is too valuable in New York for that—and is besides by far the largest from the railway and traffic point of view.

This is the new Grand Central terminal in New York, used by the

THE NEW GRAND CENTRAL TERMINAL STATION, NEW YORK.

New York Central and the New York, New Haven and Hartford Railways. There are magnificent halls, with shops of all kinds, restaurants, waiting-rooms, all on a grand scale of which some indication is given by our pictures. The vaulted ceiling of the great "concourse" is decorated to show the starry constellations, and the hall is lighted by six enormous windows. In addition, there are two sky-scraper hotels, a huge block of offices and other buildings.

But it is when we go below the road level that the station becomes most remarkable. Twenty feet down, reached by slopes instead of stairways, is the "express" or main line station. Here there are no fewer than twenty-nine platforms for trains, besides others for luggage and what is termed "express" traffic, with lines for storing cars, making a total of forty-two tracks. Yet this is only part of the station, for another twenty-four feet down is another station for local trains, with fifteen platforms and twenty-five tracks. Here some of the lines are extended in a loop from one side of the station and round to the other, so that some of the trains do not need to reverse. The trains are all run by electricity on this section.

New York has another magnificent station in the Pennsylvania

terminal. This has twenty-five platforms, so that it is a good second to the Grand Central station. This station also has magnificent buildings, shops, etc., and were it not for its New York Central companion would be the largest in the world.

America has many other large and fine stations, especially those known as "Union" depôts, where several railways have combined to build one big central station among them. Perhaps the biggest is that at Washington, said to have been built to deal with the special crowds for the Presidential elections, once every four years, and much too big all the rest of the time. Here there is a special suite of rooms for the President — something like the royal waiting-rooms provided elsewhere.

But we must look also at Great Britain, for despite the palatial buildings for railway stations in other parts of the world, our own country comes first for numbers of trains and heaviness of traffic. Not many of our stations have been built for show, and as a rule a hotel and a block of

NOT A CATHEDRAL, BUT A STATION!
A corner of the main waiting-room, Pennsylvania Station, New York.

offices erected over and alongside the station buildings is all we combine with the station proper.

Waterloo is our largest, with twenty-one platforms, and four others below ground for electric tube lines. And when the reconstruction is finished it will be really a fine station, worth looking at and talking about. It is, besides, a very busy station, used by millions of passengers every year.

Next in England comes the Great Eastern terminus at Liverpool Street, with eighteen platforms and over 1,000 trains every twenty-four hours. Here also there are two underground stations below or connected with the station, though they do not belong to it.

Other big stations in England are the Victoria station of the Lancashire and Yorkshire Railway in Manchester (seventeen platforms); Victoria Station in London (London, Brighton and South Coast Railway—sixteen platforms, South Eastern and Chatham Railway, eight platforms); Crewe, London and North Western Railway (fifteen platforms); New Street, Birmingham (fifteen platforms); Newcastle Central, North Eastern Railway (fifteen platforms), and quite a large number with more than ten platforms.

At Blackpool there are two big stations and each has an excursion

[*E. N. A.*

LEIPZIG STATION, COMPLETED DURING THE WAR, IS SAID TO BE THE LARGEST RAILWAY STATION IN EUROPE.

[*Underwood & Underwood.*

VICTORIA STATION, BOMBAY.

station alongside, so that altogether Talbot Road has fifteen and Central fourteen platforms to deal with the enormous holiday traffic.

Among junction stations Clapham Junction (L. & S.W. and L.B. & S.C. Railways) is without equal in the world. Here there are seventeen platforms dealing with about 2,000 trains every twenty-four hours, and no fewer than twelve trains can pass through at the same time.

Scotland has the second largest station in the United Kingdom. This is the famous "Waverley" station of the North British Railway in Edinburgh. Hidden away in a deep valley, so that trains reach either end through tunnels, is a huge island platform 1,680 feet long with fifteen other platforms let into it, seven at one end and eight at the other, besides other platforms outside, making nineteen in all. In Glasgow, however, the Caledonian Railway has its fine "Central" station (thirteen platforms and four below), though the Glasgow and South Western terminus at St. Enoch is nearly as remarkable. Aberdeen has a big new joint station with thirteen platforms belonging to the Caledonian and Great North of Scotland Railways.

Ireland has a number of fine station buildings, but as a rule they are not very large inside.

LARGE RAILWAY STATIONS

On the Continent many of the stations are fine buildings, even if they have few trains. The busiest is the Gare St. Lazare of the Western State Railway of France, in Paris. Other fine stations are the Gare de Lyon, the Quai d'Orsay and other Paris stations, the Cologne, Leipzig and Frankfort stations in Germany, and some of the Italian stations, especially that in Turin.

In India some of the stations are almost like palaces, that of the East Indian Railway at Howrah in Calcutta and the Victoria terminus of the Great Indian Peninsula Railway in Bombay. Australia has two immense stations, one the Central Station of the New South Wales Government Railways in Sydney and the other the Flinders Street station in Melbourne of the Victorian Government Railways, both with fifteen platforms and very busy.

In Buenos Ayres is the Retiro station of the Central Argentine Railway, a magnificent building with ten platforms.

A REMARKABLE LOOP LINE AT YANKEE DOODLE LAKE, DENVER AND SALT LAKE RAILROAD.
The topmost track, on which a train is seen, is 1,000 feet higher than the lowest.

Alfieri.

A BAD SMASH.

The Break-down Train

THINK for a moment of the many lines of railways that cross and recross our country like a great network of metal; try to imagine the thousands of splendid engines throbbing with powerful and yet delicate machinery; the tens of thousands of carriages; the many millions of human beings who are carried in the course of a year by steam-power along the shining rails, at a speed which sometimes exceeds a mile a minute. Then think how amazing it is that during a whole quarter it frequently happens that not a single passenger is killed in an accident on the railways of Great Britain. Sometimes a whole year passes without a single serious mishap. Indeed, it is well said that of all means of travelling the railway is the safest; and that there is far greater risk in walking for an hour along the streets of a big city like London than in riding by train from one end of the land to the other.

Accidents, of course, sometimes happen; but that they occur so seldom is a striking proof of the wonderful way in which our railways are managed, and of the great care that is taken in even the smallest details concerning the running of a train. One company alone carried in twelve months over one hundred and ten millions of passengers in perfect safety, while the London Underground lines together carried about four hundred millions.

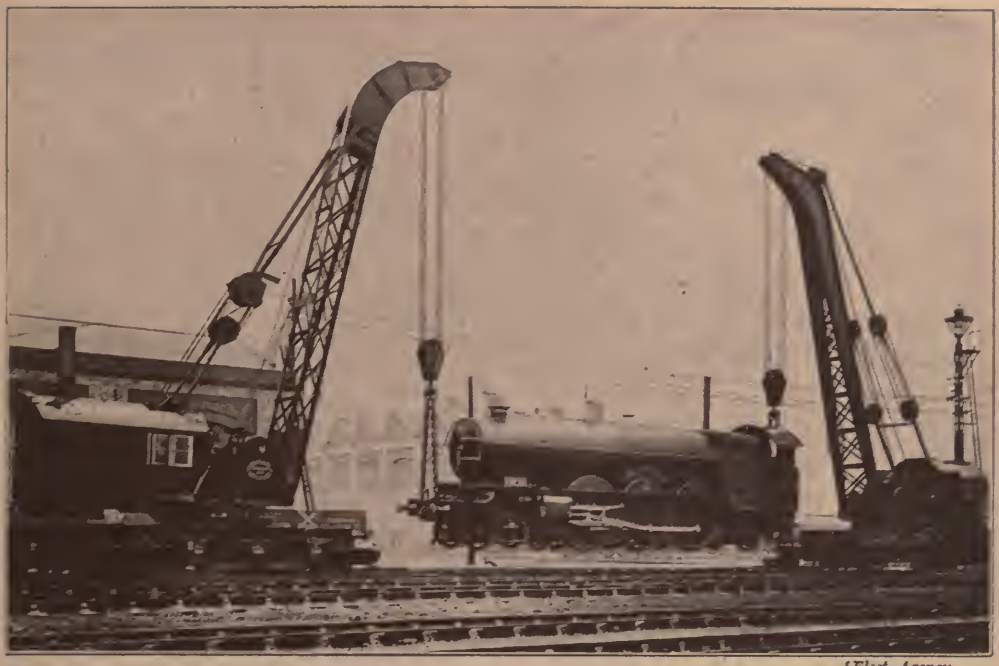
But although accidents are not frequent in our country, the railways are always in readiness for a break-down. Here and there on a

siding along the chief lines may be seen a strange-looking train without an engine attached to it. Here are a plain carriage to carry workmen when they are wanted, and vans ready loaded with iron bars, planks and shovels, rope, chains and pulley-blocks, tools, lamps and fog-signals, and on a massive iron truck in front is a huge crane for the purpose of lifting heavy weights. The jib of the crane—that is the end containing the big pulley over which the chain runs—is lowered across a truck behind it so that it may be clear of all bridges and tunnels. This is the "Break-down Train." It may remain idle on that siding for weeks, but it is always ready for instant use. Someone has called it "the fire engine of the line, always fit for instant service, but when or whence the call may come nobody knows."

Let us imagine that an accident has happened on the line several miles away. A telegram tells the news to the foreman in charge of a

[*Illustrations Bureau.*

BREAK-DOWN CRANES AT WORK AFTER AN ACCIDENT TO THE SCOTCH EXPRESS.



[*Fleet Agency.*

TWO 36-TON CRANES LIFTING THE HUGE "GREAT BEAR."

shed close by, and at once he sends for the crew of the "Break-down Train." They work and live close by, and in a few moments are to be seen running at top speed towards the siding, some of them, if it is night-time, putting on their coats as they hurry along.

In the meantime the nearest engine has been coupled on, and soon the train is rushing swiftly towards the scene of the accident. There is nothing along the line in front to bar the way; for even if the King himself chanced to be travelling his train would be turned aside at the first junction to make way for the "Break-down Train."

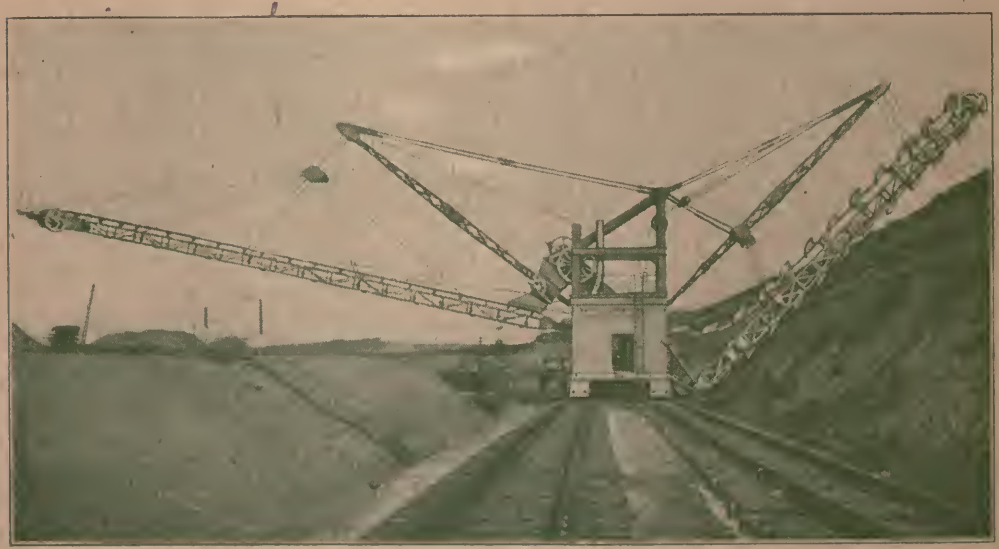
When the scene of the "smash" is reached, the crane jib is lifted to its full height and, in charge of five men, sets to work clearing away over-turned carriages and other heavy weights that obstruct the line. The task set the workers is always heavy, and, as we can understand, sometimes sorrowful. The crane is at work—tugging, straining, lifting; all around is the noise of hammering and sawing, the rattling of chains and the clanging of iron bars; and, should the accident have happened at night, lamps, torches and fires add to the dreadfulness of the scene.

Terrible though accidents always must be on the railway, things sometimes occur that are funny. Once, after a smash in Suffolk, a

man was seen anxiously searching among the wreckage by the help of a lantern. A kindly fellow-passenger, supposing that he was looking for his wife, asked, "What part of the train was she in?" Raising his lantern, the searcher angrily replied, "She, sir! She! What do you mean? I'm looking for my false teeth."

Not pleasant to the sufferer, but a very comical sight to those who saw it, was an accident that once happened to a small boy, entirely through his own fault. He was on his way by train, in the company of some young friends, to school at Coventry, and to amuse himself the little rascal mounted on the shoulders of two comrades and pushed his head through the empty hole for the lamp in the roof of the carriage. Having enjoyed the scenery from that novel look-out, the boy found—like many far wiser than he—that it is easier to get into a tight place than to get out of it. He tried to withdraw his head, but could not. His companions called to a railway servant, and he also failed to get that unlucky head back into its right place. At last the carriage had to be uncoupled and sent into a siding, where, after an hour's work with that part of a "Break-down" outfit which consists of a saw and a file the head was released, and carried away safely to school on the shoulders of the hero of one of the most amusing railway accidents ever recorded.

W R. R.



A COMBINED EXCAVATOR AND CONVEYOR.

The manual labour saved by such machines is enormous. By their help cuttings are made at a rapid rate. One part of the machine does the digging, while another part conveys the soil to ballast wagons, by which it is carried away.

A 4-4-0 NORTH BRITISH LOCOMOTIVE OF THE "GLEN" CLASS.
These fine engines work on the North British system, taking express, stopping, or goods trains.

The Handymen of the Line

ON all big railways there are express, goods and tank engines; but a great deal of miscellaneous work has also to be done which is not exactly the duty of any particular class. In many cases the difficulty is got over by using any engine which is available, and which is not altogether unsuitable; but on a number of lines what are known as "mixed-traffic" locomotives are provided specially for such duties.

The general idea is that such engines shall be able to travel reasonably fast if required; but that their coupled wheels are smaller than those of the express engines, so that they can pull heavier passenger train loads, and can also manage very well with a normally heavy goods train. Such engines are also employed on sections of main lines where there are steep inclines, and very high speed is therefore not expected; and they are very useful on branch lines and for trains which stop frequently.

In fact, although the ordinary engines do a great deal of work which does not really belong to them, these "mixed-traffics" are better fitted for miscellaneous duties, and can therefore be used as "handymen" on all sorts of work, and manage very well whatever form it takes.

A good many older express engines do work of this kind, but the true "mixed-traffic" has coupled wheels about 5 feet 6 inches, or not more than 6 feet, in diameter. They can thus travel fairly fast, up to about seventy miles an hour occasionally, though their usual top speed is about fifty miles an hour. They can also pull heavy passenger

trains, get away quickly from stations, and if required can take a 400 or 500-ton goods train without special difficulty.

Nowadays "mixed-traffic" engines are mostly 4–4–0, 2–6–0 or 4–6–0. The 4–4–0's are really small-wheeled versions of 4–4–0 express engines. They are very numerous on the Great Western and the London and South Western Railways; and many other lines have them in considerable numbers. On the North British Railway there is an interesting class known as the "Glens," and one of these is illustrated. These were intended mainly for working the West Highland Railway, that beautiful line which passes for about one hundred miles through the Scotch mountains from Craigendoran to Fort William and Mallaig, where they take all trains, express, stopping and goods. But they are now used all over the North British system, even working express trains between Edinburgh and Glasgow.

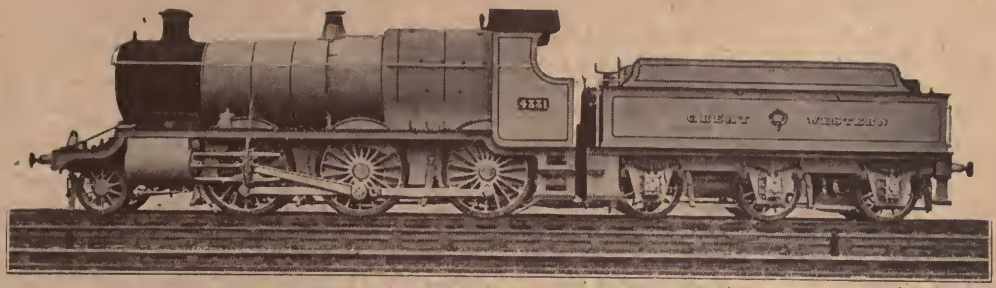
But as it has been found necessary to use six-coupled engines for express work, so we now have many "mixed-traffics" of the same class, but with coupled wheels 5 feet 8 inches or 6 feet in diameter, instead of 6 feet 6 inches or 6 feet 8 inches, as for the high speed engines. Many of these engines are of the 2–6–0, or "Mogul," type.

The Great Western engines of the "5000" class work all over the line. In the West of England they haul express trains, including the "Cornish Riviera" express between Plymouth and Penzance, and in many other places they work express trains where the inclines are severe, and speeds, therefore, only moderately high.

Other railways employ small-wheeled 4–6–0 engines for mixed-traffic duties. On the Great Central there are engines with 5-feet wheels and with 5-feet 9-inch wheels, and the same classes are found on the Caledonian Railway. The London and North Western uses the 4–6–0 "Experiment" and "Prince of Wales," mentioned as express engines, largely for mixed-traffic duties, but also has a numerous class with 5-feet wheels only, and these are the true "mixed-traffic." The London and South Western Railway has 6-feet 4–6–0 engines classed as "mixed-traffic," though they often take express trains.

But the most remarkable mixed-traffic engine yet built is No. 4700, Great Western Railway, of which an illustration is given. This is an eight-coupled engine but, unlike the 2–8–0 engines which work universal trains on that line, is really an enlarged version of the "5000" class of 2–6–0 engines, with a fourth pair of 5-feet 8-inch coupled wheels added, and a larger boiler to correspond.

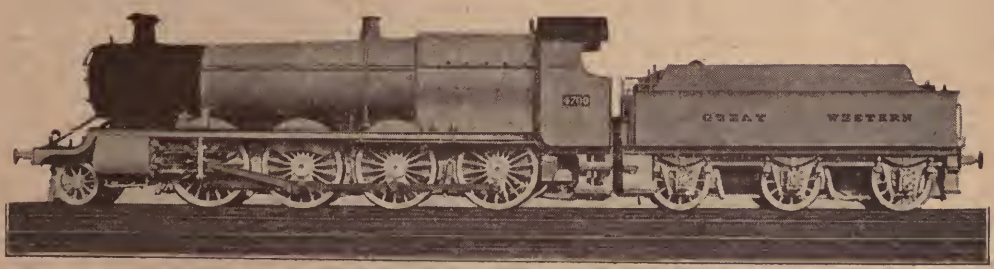
SOME "HANDYMEN"



A 2–6–0 MIXED-TRAFFIC GREAT WESTERN LOCOMOTIVE.

A 2–6–0 MIXED-TRAFFIC LOCOMOTIVE, SOUTH EASTERN & CHATHAM RAILWAY.

A 4–6–0 GREAT SOUTHERN & WESTERN RAILWAY (IRELAND).



A 2–8–0 MIXED-TRAFFIC LOCOMOTIVE, GREAT WESTERN RAILWAY.
This is one of the most remarkable of mixed-traffic engines, as it is eight-coupled.

R. C. Carter] *[Winnipeg.*
A 4–6–2 ENGINE HAULING THE "TRANS-CANADA" EXPRESS, CANADIAN PACIFIC RAILWAY.

The Canadian Pacific Railway

THE British Empire has reason to be proud that it includes within its limits the vast Dominion of Canada, an area of mighty mountains and rivers and lakes, and of far-stretching plains that are among the most fertile regions of the world.

It was difficult to imagine that there could be any real bond of union between the states of a country like Canada, with a population less than that of London and an extent from the Atlantic to the Pacific Ocean nine times the length of England. But with the making of the Canadian Pacific Railway, one of the grandest and most important railway systems in the world, this union was brought about.

British Columbia, on the Pacific side of North America, a country rich in minerals and timber, and having rivers teeming with salmon and trout and mighty sturgeon, was not always a part of the Dominion of Canada. In 1871, the people of Columbia were invited to join the then recently-federated Canadian States, but they answered—"There would be no use in our becoming part of your Union. Between you on the Atlantic side and ourselves on the Pacific side there stretch hundreds of miles of prairie land where no human beings dwell; we are separated from you by great belts of mountains; and between

us wide rivers roll. Make a railway across the continent by which we can easily travel to trade with you and you with us ; then we shall feel that we are actually a part of Canada and will gladly join the Union."

This proposal for an iron track nearly three thousand miles long from the Pacific to Montreal caused worry to the Canadians. They thought of the difficult rocky districts on the north side of Lake Superior ; of the nine hundred miles of prairies gradually rising westward ; of the vast ranges of the Rocky Mountains that stood like a mighty wall in the way, great masses that were as little known then as the ranges of Central Africa are to-day ; they wondered how supplies and labour could be found amid so scanty a population ; and they doubted whether such a vast work could be steadily carried out amid the storms and drifting snow of a Canadian winter.

But the Government, full of courage and very earnest, said among themselves, " If the railway would be of service to British Columbia it would be of even more importance to us," and they sent word to the people on the Pacific shore that the railway should be made. In 1871 British Columbia became one with the Dominion of Canada.

But the work went on so slowly that after seven years had passed not a fourth part of the length was laid. The men of British Columbia were so loud in their complaints that at last the Canadian Government invited a number of rich people to take the matter in hand. This they readily did, but they made the Government promise them much in return. The Company formed to make the Canadian Pacific Railway were assisted by the Government to the extent of five millions of money and nearly six millions of land ; and further they were promised that the railway should never be put under taxation, and that the length of seven hundred miles of lines already laid down

A 4–8–2 MOUNTAIN LOCOMOTIVE, CANADIAN PACIFIC RAILWAY.
This type is used for hauling very heavy loads up steep gradients.

should be made over to the Company free of any charge. On the other hand the Government said—"If we do this to help you, you must promise on your part to have the whole railway completed in ten years." "Yes," said the Company, "we promise."

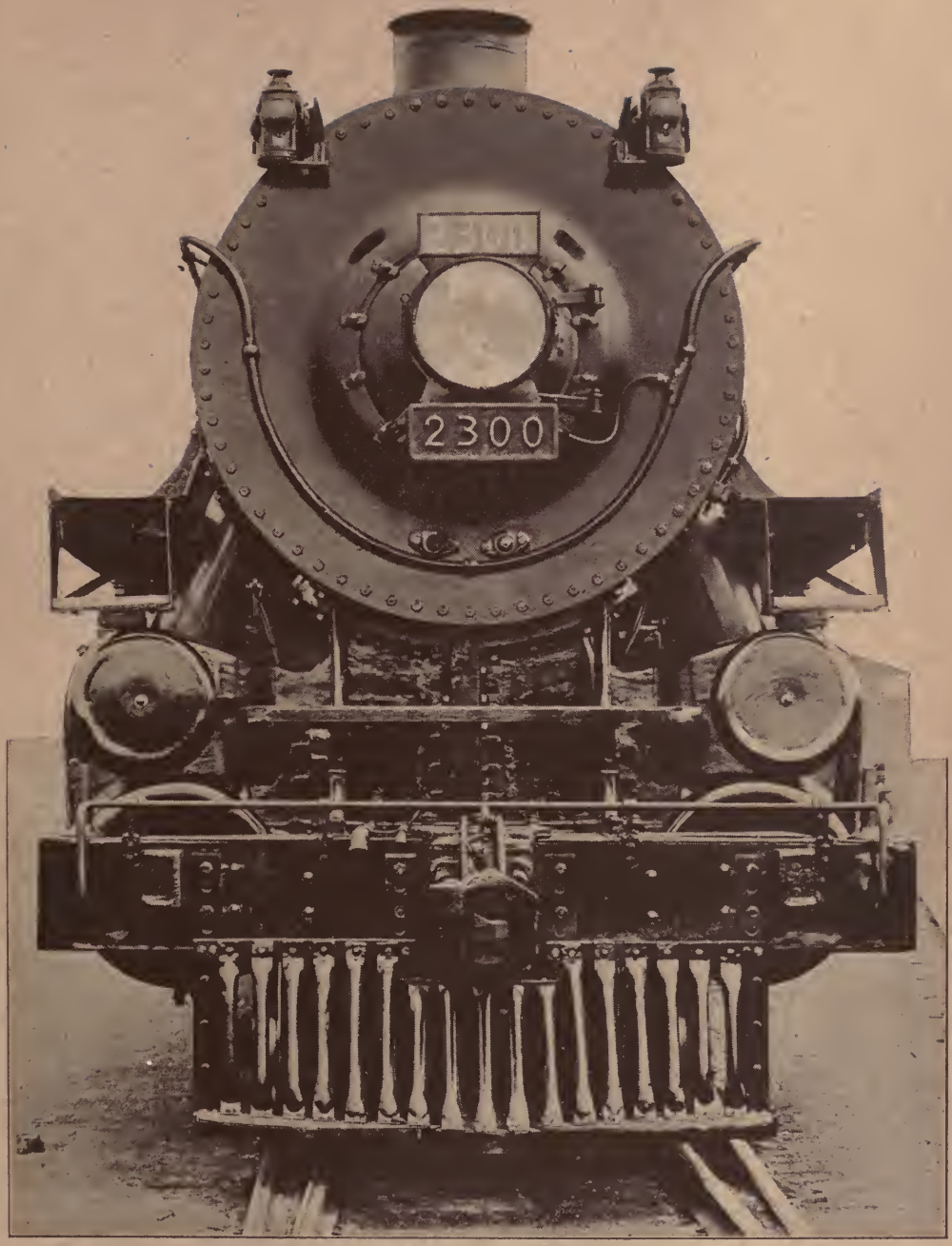
The first thing to be done was to find the best and easiest route along which the railway should pass. An exploring party was sent out, and after a survey of two years, they brought back their report, and a vigorous start was made. What these explorers had to endure in the higher regions from the intense cold may be imagined from the fact that they sometimes had to beat one another with leather straps to keep the blood moving.

The first part of the track-laying was through the district where the new railway was sure to pay best—namely from Lake Superior to Manitoba, the richest corn-growing country in the world. Here the difficulties were very great; for the rocks of granite and flint were so hard that three millions of money were spent in making the line running along the northern shore of Lake Superior, the cost of the dynamite used in blowing away the rocks amounting to nearly half a million pounds. Another trouble was the number of "muskegs," that is, lakes concealed by a great thickness of soil, but yet not thick and solid enough to carry a railroad track. Such vast quantities of timber and other heavy matter had to be thrown in to make the way firm that the engineers began to think they had found a bottomless pit. But not only did this part of the line prove the most profitable, but by travellers it was regarded as one of the most interesting portions of the journey, passing as it did for a number of miles amidst the romantic rocks and within sight of the glorious waters of Lake Superior, that mightiest of all the fresh-water lakes in the world, stretching from east to west over four hundred miles.

When the rocks by Lake Superior were passed, and the prairie reached, long stretches of the line were rapidly made; but although much of the railway was quickly constructed it was all well-built and of the best materials; in fact, a first-class permanent way was laid down.

The railway reaches its highest level in what is called the Kicking Horse Pass, across the Rocky Mountains, where there is a little station at a height of 5,321 feet above sea-level. Here the line enters British Columbia.

Early on the morning of November 7, 1885, the track of railway



A MONARCH OF THE RAIL.

The front of a 4–6–2 passenger locomotive, Canadian Pacific Railway. An engine of this type hauled the Prince of Wales's train during his Canadian Tour in 1919.

begun from the Pacific Ocean side was very near to the track started on the eastern side of the Continent; an hour or two later the last rail was laid, and from the Pacific to the Atlantic there stretched a line of shining metals bringing the vastness of Canada into the Union that had been so long desired. All that remained to finish the work was the driving in of the last spike, and this was done by one of the Directors of the Company, long known and honoured all over the British Empire, Lord Strathcona, who died in 1914. When this last spike was driven in, the site of the present city of Vancouver, at the Pacific end of the railway, was an almost untrodden forest; to-day, with its population of over one hundred thousand, and its grand, land-locked, mountain-sheltered harbour, Vancouver is counted among the gateways of the world.

The Canadian Pacific Railway is the nearest route from England to China and Japan, to Australia and New Zealand; it has helped in making Canada from ocean to ocean a united nation; and it has forged one of the strongest of all the links in the chain that binds the British Empire.

W. R. R.

[*By courtesy of the C.P.R.*

"GOOD-BYE!"

The Prince of Wales taking leave of the train staff on the conclusion of his tour through Canada.

A LONDON & NORTH WESTERN ELECTRIC TRAIN.

Electric Railways

A STEAM locomotive carries everything with it. So does a locomotive working by petrol or by means of compressed air. Some of the early electric locomotives carried batteries for producing current, or accumulators in which electricity was stored, but those means were found to be of no use with heavy trains. Therefore, every electric railway now supplies current by means of overhead wires (in the same way as for tram cars), or by conductor rails alongside the ordinary ones. On the train there are collectors, or "shoes," which rub either along the overhead wire or upon the conductor rails and so collect the electricity for working the motors.

There are two types of electricity, described for want of better terms, as "direct" and "alternating." Direct current travels always the same way, and is the kind generally used. Alternating current goes continually backwards and forwards, alternately in one direction, then in the other.

Really the electricity is first produced by the dynamos in the power station as alternating and the opposite direction movements have to be reversed to convert it into direct current. Direct current requires to be used much weaker than alternating current, so that it is necessary

to "transform," or reduce, from a high pressure, or "voltage," of, say, 11,000 volts to 600 volts or so, while alternating current can be used at 7,000 volts.

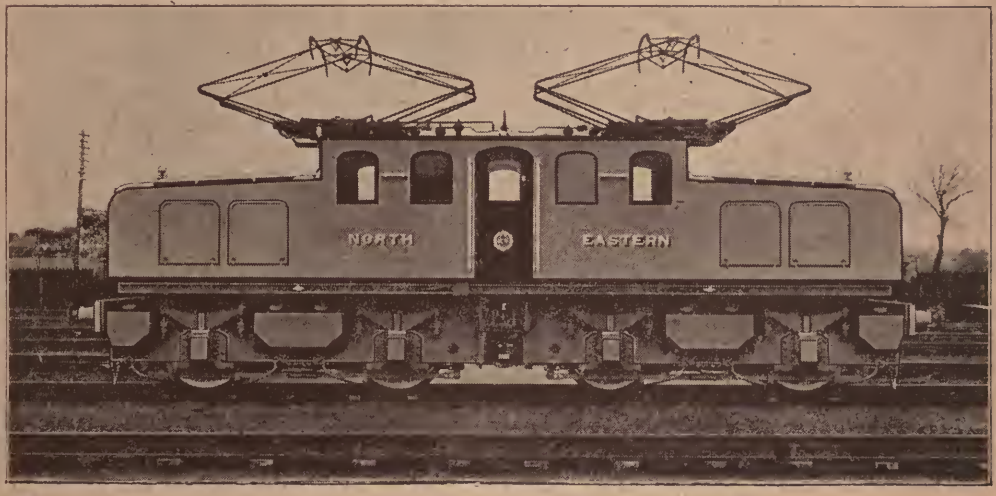
For these and other reasons, engineers have been trying for years to use alternating current for railways, and there are several lines where this is done. But ordinary electric railways all use direct current, as the apparatus is much simpler.

The first important electric railway in the world was the City and South London Tube Railway, in London. On that line small locomotives have been used ever since 1890, the passenger carriages being all pulled

ALL-STEEL ELECTRIC TRAIN USED BETWEEN MANCHESTER AND BURY, LANCASHIRE & YORKSHIRE RAILWAY.

by the engines. The Central London Railway—long called the "Two-penny Tube"—at first also had locomotives. But this and the other electric railways in London, as well as most of the electric lines in other great cities, now use motor carriages instead of locomotives. That is, the driver, or motor man, travels in the first compartment of the leading carriage, and the motors are fitted under this and sometimes under several other carriages, so that there is no need for a separate locomotive, and every vehicle carries passengers. Special apparatus is provided so that the driver can control the motors under other carriages as well as those under his own.

ELECTRIC LOCOMOTIVE HAULING A MINERAL TRAIN, NORTH EASTERN RAILWAY.



AN ELECTRIC FREIGHT LOCOMOTIVE, NORTH EASTERN RAILWAY.

[*Topical.*

A TRAIN ON ONE OF THE ELECTRIFIED SECTIONS OF THE LONDON & SOUTH WESTERN RAILWAY.

All the Tubes, and, in fact, all small railways in this country and some of the big ones, use conductor rails for supplying current. Most of them, indeed, use two rails for the purpose. The current from the power station must be able to return, or it will do nothing, so what is known as a "positive" rail is placed outside the running rails, sometimes on one side, sometimes on the other, while a "negative" rail is placed in the middle. In other cases engineers do without a negative rail and allow the current, which is not dangerous in going back to the power station, to return through the running rails. Thus on the City and South London and the Central London Railways the rail in the centre is the positive conductor, and the current returns by means of the ordinary rails. On the electrified parts of the London and South Western Railway, too, there is only the positive rail, but that is placed outside the others.

MOTORMAN'S COMPARTMENT, LONDON, BRIGHTON & SOUTH COAST ELECTRIC TRAIN.

Besides the London Underground Railways there are several others in England which use direct current and collect from conductor rails. Instances are the Liverpool Overhead Railway, which serves the long line of docks on the Liverpool side of the Mersey; the Mersey Railway, which tunnels under the river there; the North Eastern Railway lines

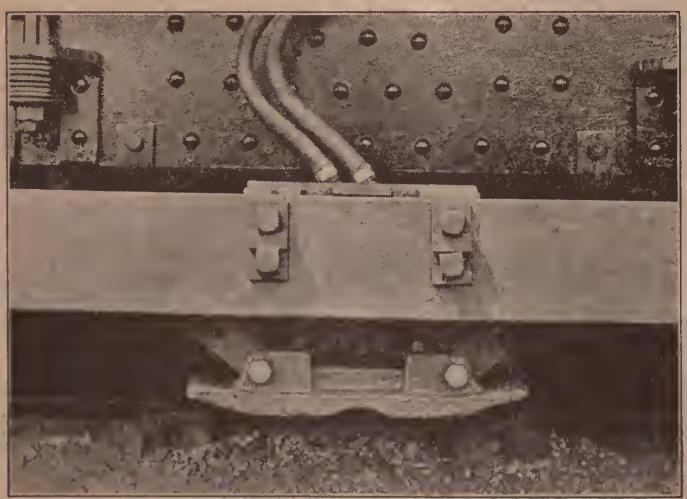
ELECTRIC PULLMAN TRAIN, METROPOLITAN RAILWAY.

A 4–4–4–4 ARTICULATED DIRECT CURRENT 4,000 HORSE-POWER ELECTRIC LOCOMOTIVE, PENNSYLVANIA RAILROAD.

from Newcastle to the coast; and the Lancashire and Yorkshire Railway lines from Liverpool to Southport, Aintree, and other places near by. In Manchester, too, the Lancashire and Yorkshire Railway has electric trains running to Bury, but these use a higher pressure of direct current — 1,200 instead of 600 volts.

VERY DIFFERENT FROM THE CAB OF A STEAM ENGINE.
Interior of a Metropolitan Railway Electric Locomotive.

In London, both the Metropolitan and the District Railways have a few electric locomotives, but most of their trains consist of motor-cars, with trailer, or non-motor, carriages between. These locomotives are used to pull the ordinary carriages or trains which go beyond the electrified portions of the line and are worked by steam locomotives for portions of their journey. Such electric locomotives can be used also when required for pulling goods wagons and for working goods trains.



THE COLLECTING SHOE OF AN ELECTRIC TRAIN

But London has also another set of electric railways, those of the London, Brighton and South Coast Railway. Here there are overhead wires instead of rails for supplying current, and the trains have what are known as "trolleys" on top, which rub against the wire and so collect current. In

AN ITALIAN ELECTRIC LOCOMOTIVE.

this case the current is alternating and at the high voltage of 6,600, so that the working is very different from that on other railways. All along the line are girders which project over the track to support the overhead conductor wires, and this forest of iron-work gives the railway a curious appearance. These trains work between Victoria and London Bridge and the Crystal Palace, and many more lines will be fitted in the same way before long. The Midland Railway has a line worked in the same way between Lancaster, Morecambe and Heysham.

In Yorkshire there is a line belonging to the North Eastern Railway which connects Shildon with Newport, near Middlesborough, by means of which coal is sent down to the coast in trucks by the thousand. This line is now worked by electric locomotives, which pull as heavy loads as did the powerful steam locomotives previously used. Overhead wires are installed, but the current is direct, though at the high pressure of 1,200 volts. So far, this is the only electric railway in Great Britain on which heavy goods and coal traffic is worked; but in other countries there are many such lines. In America, the underground and overhead lines in New York and certain other cities all use conductor rails and direct current, but

A THREE-COACH ELECTRIC TRAIN, LONDON, BRIGHTON & SOUTH COAST RAILWAY.

in other places there are important lines where overhead wires are used and high-pressure current, direct or alternating, is employed.

In Paris and Berlin the underground railways use conductor rails, and the new electric lines at Buenos Ayres, in the Argentine Republic, are similar; but most of the many electric lines in Italy, Switzerland, Germany, Sweden, Norway, etc., have overhead wires. Some of these lines are, in fact, special in other ways, using alternating current of a power and character which we in this country have not tried yet.

In Switzerland some of the mountain rack railways are now worked by electricity, and through all the great Alpine tunnels, Mt. Cenis, St. Gothard, and the Simplon, electric locomotives pull the trains. In the United States, too, electric locomotives pull trains through certain long tunnels, and in at least one instance they haul the steam locomotives as well, to avoid changing.

Some of the great electric railways in the United States are very remarkable. A previous article, "The Longest Electric Railway," describes one of the most interesting of these. This is the Chicago, Milwaukee and St. Paul Railway, which possesses huge electric locomotives of 3,440 horse-power, which can haul 800-ton passenger trains at 60 miles an hour. Before many years have passed it is probable that many British Railways will possess long stretches of line adapted to electric traction.

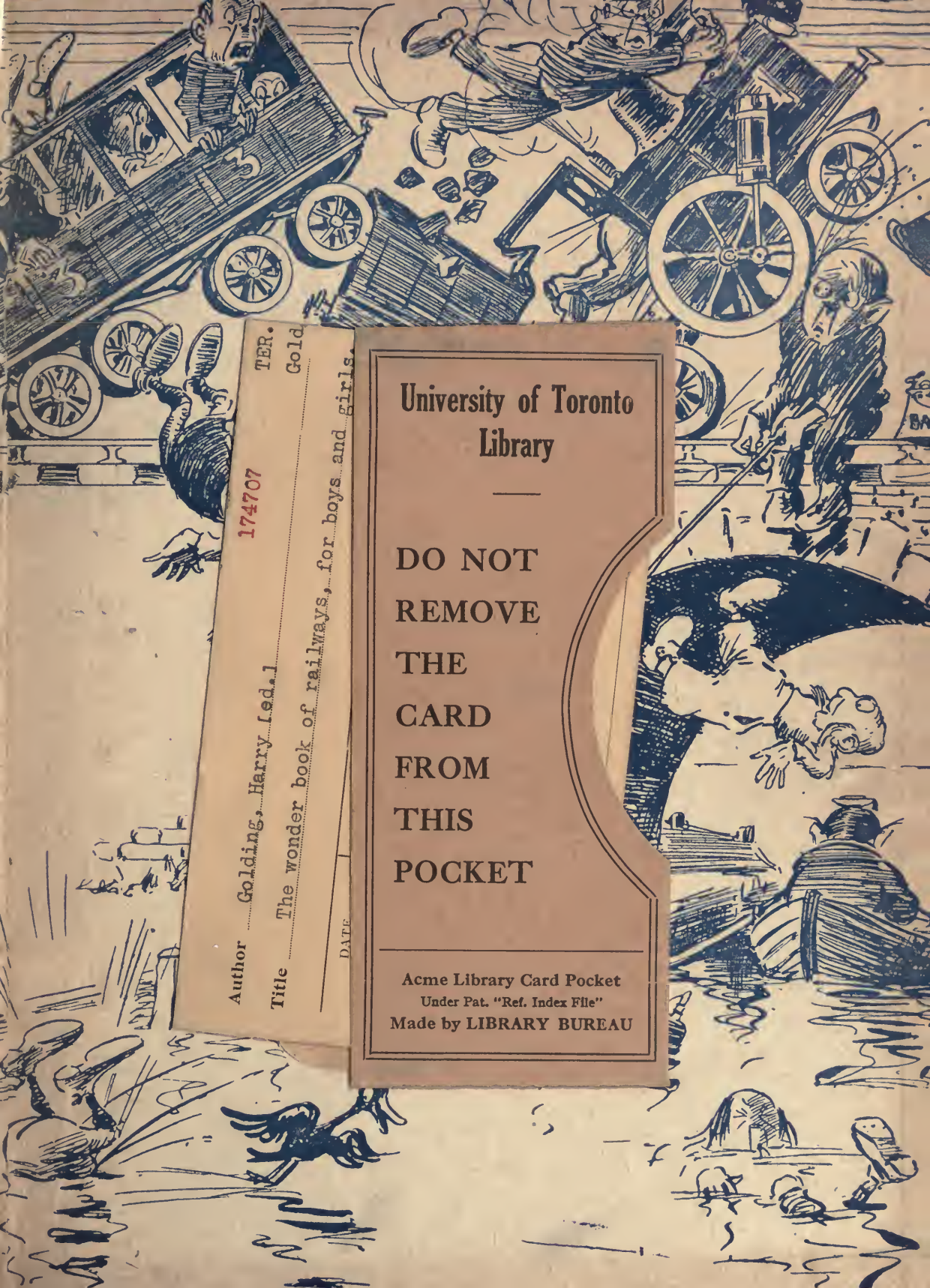
J. F. G.

[*W. W. Stewart.*

THE END.

The Prince of Wales saying "Good-bye" to New Zealand, 1920.

Printed in Great Britain by Butler & Tanner, *Frome and London*



174707

Author Golding, Harry [ed.]

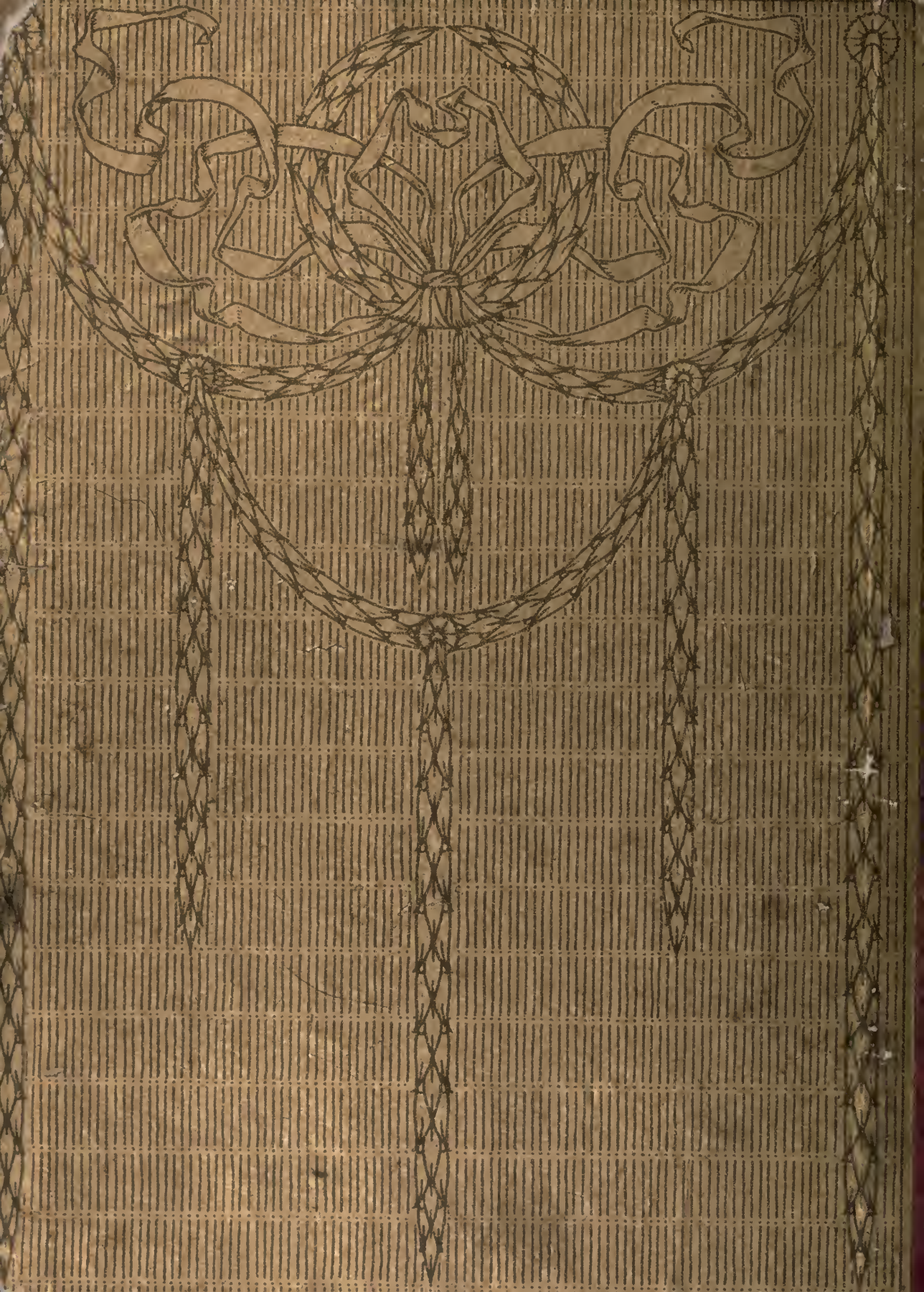
Title The wonder book of railways, for boys and girls.

TER.

Gold

DATE

University of Toronto Library

DO NOT REMOVE THE CARD FROM THIS POCKET

Acme Library Card Pocket
Under Pat. "Ref. Index File"
Made by LIBRARY BUREAU